SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS G'.

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SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA,

907 Walnut Street, Philadelphia.

SUSQUEHANNA RIVER REGION

IN THE SIX COUNTIES OF

WYOMING, LACKAWANNA,

LUZERNE, COLUMBIA MONTOUR,

AND

NORTHUMBERLAND.

By I. C. WHITE.

✓ WITH A COLORED GEOLOGICAL MAP IN TWO SHEETS;
AND 31 PAGE PLATES IN THE TEXT. ✓

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PREFATORY LETTER.

To his Excellency ROBERT E. PATTISON, *Governor of Pennsylvania, Ex-officio Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania:*

SIR: I have the honor to submit to your favorable consideration a report of the progress of the Survey in the Devonian and Silurian region of Middle Pennsylvania lying north and west of the Anthracite Coal fields, in Wyoming, Lackawanna, Luzerne, Columbia, Montour, and Northumberland counties, by Professor I. C. White, whose reports on Beaver, Lawrence, Mercer, Crawford, and Erie counties* along the Ohio state line, and on Susquehanna, Wayne, Pike, and Monroe counties† along the New York and New Jersey State lines have been already published.‡

In this, his seventh report, Mr. White confines his attention *exclusively* to the *Devonian* and *Silurian* formations, because the Survey of the Bernice, Mehoopany, Wilkes-Barre, Scranton, and Carbondale *coal fields* is in progress and will be reported separately by Mr. Ashburner.

§1. He finds fossil-bearing beds high in the *Catskill* formation, some of the organic forms appearing to be of *Chemung* type.‖

§2. The *fish-bearing* calcareous breccias of the Delaware

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*Q, Q^2, Q^3, Q^4. †G^5 G^6.

‡The editing of this report, proof reading, indexing, &c., by myself, without assistance from the author, has been rendered necessary by his absence in Huntingdon county, the survey of which was entrusted to him during the field season of 1883. I am therefore personally responsible for all typographical errors.

‖Respecting the palæontological questions raised by this and other remarkable features of this report, see further on under §24.

river country extend south-westward down the Susquehanna valley into Middle Pennsylvania, where Prof. Claypole is observing them upon the Juniata river.

§3. A supposed necessity for *two transition series* at the upper and lower limits of the *Catskill*, one *Pocono-Catskill*, the other *Catskill-Chemung*, is explained and illustrated in this report.

§4. A notably fossiliferous portion of the *Chemung* receives the new name of *the Stony Brook group*, and is traced from Luzerne to Dauphin and Perry counties.

§5. The difficulty of separating *Chemung* from *Portage* is shown.

§6. The presence of the *Tully limestone*, beneath the *Genesee slates*, in this part of Pennsylvania, is demonstrated.

§7. The sudden enlargement of the *Hamilton*, southward from Montour's ridge, by the introduction of the *Selinsgrove sandstone, shale, and limestone group*, is illustrated by numerous local sections.

§8. The doubtful and variable character of the *Corniferous* and *Caudi-galli*, and the local existence and non-existence of the *Oriskany*, will interest geologists.

§9. The *Stormville group* of Pike and Monroe counties, at the top of the *Lower Helderberg* formation, is recognized in Montour and Northumberland counties. Perhaps the most important feature of the report is a close study, at numerous localities, of the *coral reefs* and *quarry limestones* which crop out along both flanks of Montour's ridge from Berwick westward to the West Branch ; in the region of Milton, Watsontown, and Washingtonville ; and in Southern Northumberland on the main Susquehanna river. The *Bastard* and *Bossardville limestones* are especially described.

§10. To the *Salina formation* of the New York geologists Mr. White pays particular attention. He shows that it is amply represented in our Susquehanna river country, and is there divisible, as in New York, into Upper, Middle, and Lower. He gives to the *Lower Salina* the new name of *Bloomsburg red shale*, and removes it from

the *Clinton formation* (*No. V*) in which it was placed by the First Survey. As for the *Niagara formation* of New York, he can find no distinct place for it in our Pennsylvania series, although some of its fossils appear among those of the *Clinton.*

§11. The *Clinton formation* is described in less detail than by Prof. H. D. Rogers in 1858; I have therefore given Mr. Rogers' description in an Appendix, at the end of the volume, where a very complete account of the *fossil ore* is recorded. In the early stages of the iron manufacture the Danville-Bloomsburg outcrop of this ore was of great importance; but as time went on and larger furnaces, fed with anthracite, called for richer ores, and in quantities which the small Clinton fossil beds were incapable of producing, its relative importance so diminished, and its cost of mining so increased, that Mr. Rogers' careful description of it is all that those interested in it, whether capitalists or geologists, can require. In fact our knowledge of it was nearly as complete forty years ago as it is to-day. Other iron ore beds are added to the series in Snyder, Mifflin, Juniata, Huntingdon and Bedford counties, and descriptions of these will be found in Reports F, T, and T[2] already published, and in Reports F[2], T[3] and S yet to be published.

It would certainly be very interesting to learn how far Mr. Rogers' calculations in 1843 have been verified by the practical mining operations pursued so many years at the points mentioned by Mr. White. But the figures could only be obtained by a most laborious examination of all the private account books of the furnaces on the river for forty years. And the results of such an examination, even if possible, would be unsatisfactory because of the always increasing use of ores obtained from other regions. No actual examination of the workings would yield the requisite data, for many of the mines are abandoned and the ore varies greatly, although within small limits, in gangways which are still worked.

Nothing new in the way of the discovery of other ore beds in the Clinton series of this belt is to be expected, and

therefore its geological description may be considered practically closed.

§12. With the exception of the Clinton ore bed, and the limestone and flagstone strata traced across the region by Mr. White, the region described is singularly destitute of mineral wealth. It borders on the most affluent domain of mercantile prosperity—the Anthracite Coal fields—but is in itself of no mineralogical importance in the ordinary sense of that term. It is almost totally destitute of *coal beds*,* of brown hematite or other abundant *iron ore deposits*, of any precious metal, of *salt*, of *petroleum*. The Oil bearing rocks of north-western Pennsylvania range extensively through the region, but contain no oil.† The salt bearing formation of New York is well represented in it, but shows no sign of containing salt or gypsum. The *Marcellus shale* has broad outcrops, but the iron ores which it carries on the Juniata river country and in Virginia do not seem to extend toward the north-east. The great *limestone* formation (*No. II*) of the Lebanon valley underlies the whole region, but nowhere comes to the surface, and it is not likely that its iron is concentrated into ore at so great a depth; but if it were, the depth is too great to allow of sinking for it. The least depth at which the top of the *Trenton limestone* could be reached, viz: in the gap through Montour ridge, must be 5000 and may be 6000 feet.

§13. Great hopes have been entertained respecting the *zinc and lead ore* of the Lower Helderberg rocks. They are in the right formation, but are apparently of no practi-

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* Mr. White considers the Forkston coal bed, in Wyoming, identical with that at Bernice, in Sullivan county; see page 42. Mr. Ashburner agrees with him so far as his present knowledge of facts extends. Mr. E. B. Harden is making a careful survey of the Bernice basin. A survey of the whole Mehoopeny region has been commenced by Mr. Ashburner, the report of which will be included in the Anthracite series. The colored geological map in Wyoming county, west of the Susquehanna, is the best representation which can be made at present, until a map can be prepared from the new surveys.

†It must not be supposed that petroleum exists in north-eastern Pennsylvania because Prof. White thinks he can recognize the Venango Oil Sands in Susquehanna, Wayne and Wyoming counties. (See the last line on page 59.) The Mehoopany oil wells did not strike oil in passing through these supposed oil-sands. (See Plate XIII, Fig. 48, page 138.)

cal importance. Mr. White says little about them beyond giving their geological place in the series, because very little can be said about them. He judiciously abstains from throwing discredit upon them, simply stating that the exposures thus far are unsatisfactory, whatever they may become hereafter. I do not hesitate myself, however, to express a belief that no lead or zinc workings at any point along the Lower Helderberg outcrops in this region will pay ; and no geologist would favor exploration in the formations above or below the Lower Helderberg in this region.

§14. As for gold, silver, copper, and tin, it is hardly needful to say that all reports of their existence in the six counties covered by this report must be explained either by tradition, superstition, or fraud. As valuable ores in any shape, they are everywhere and entirely wanting, and every dollar spent in their search will be wasted.

§15. *Roofing slate*, of a peculiar kind, but of fair quality, has been quarried at one or two points along the line of the Marcellus outcrop (See Index.) It is not, however, the roofing slate of Northampton county. That belongs to a lower formation (No. III,) and is of a very different character, its lamination being due to a subsequent lateral pressure, as described in the report on Lehigh and Northampton counties, D³ Vol. 1, 1882. But an imperfect cross cleavage, nearly at right angles to the bedding, is occasionally exhibited by the Marcellus slates on the flanks of the Montour anticlinal, and has been produced, no doubt, by the same agency. (See page 271 and Index.)

§16. *Glacial phenomena* claim and receive great consideration in this report. The so-called *Terminal Moraine* of the Canadian ice sheet crosses Columbia county, and divides the region into a north-east *glaciated* portion and a south-west *unglaciated* portion, the contrast between which strikes the observer forcibly, and raises in his mind many questions, some of them not easily answered. The subject will be more extensively discussed in the forthcoming report on the Moraine by Prof. H. C. Lewis (Report Z, 1883.) A few words here will show its character and bearing on the geology and agriculture of the country.

§17. The great Moraine shows itself at the heel of Cape Cod; makes the Elizabeth islands and Block island; runs through Long island from end to end; crosses Staten island; bends north at Amboy, and makes a wide curve through New Jersey to Belvedere;* crosses the Blue mountain 4 miles west of the Delaware water gap, and ascends to the Pocono mountain plateau in Monroe county;† crosses Carbon county in a north-west direction to Beach Haven, above Berwick, on the north branch of the Susquehanna river; ascends the south slope of Lee's mountain, and descends the north slope of Huntington mountain to Fishing creek; runs north alongside of and a little east of Fishing creek to the North mountain, the top of which it reaches in Wyoming county; crosses Sullivan and Lycoming counties westward to Ralston, and Potter county to Olean.‡ At Little Valley, in the State of New York, it turns at a right angle and runs south-west to Beaver county.§ Across the State of Ohio it described a great curve to the Ohio river above Cincinnati.‖. After an excursion into Kentucky, it recrosses the Ohio river below Cincinnati, traverses Indiana, Illinois, Wisconsin, Minnesota, and Manitoba, and is lost in the unexplored country west of Baffin's bay.¶

The Moraine, where undisturbed, is a ridge of loose rocks, sand and clay, a hundred feet high and several hundred yards broad at its base; its materials being fragments of all the surface formations collected and carried southward by the great ice sheet in its movement from Canada across the State of New York and the northern counties of Pennsylvania; and left standing in a disorderly heap along the line at which the ice-front melted away. As the ice-

* See the New Jersey Geological reports.

† See Report G[6] on Pike and Monroe.

‡ See Reports I, I[3], I[4] of Mr. J. F. Carll.

§ See Reports Q, Q[2], Q[3] of Mr. White and V of Mr. Chance.

‖ See the publications of Rev. G. F. Wright, 1883.

¶ Most of the time of the Geological section of the Am. Ass. for the Advancement of Science, at its August meeting (1883) at Minneapolis, was consumed in descriptions of this remarkable ring-mound of sand, gravel, and bowlders, by Hitchcock, Upham, Orton, Wright, Chamberlain, Stone, Newberry, and others who were present.

sheet covered the entire country, the high mountain plateaus and the low valleys alike, the Moraine is in some places 2000 feet above ocean level, as on the North mountain; in others only 500 feet, as at Berwick. As the ice-sheet protruded its tongues south-westward along the existing valleys, the general north-west course of the Moraine is bent into curves, some of them quite sharp; as for example where it rides over the two neighboring crests of Lee's and Huntington mountains, west of Schickshinny in Columbia county.

Just here are some of Prof. White's most interesting observations (see page 269.) He shows that the glacier put out a short tongue up the narrow valley of the West or Little Shickshinny creek, the west end of which tongue reached to a point between the two notches in the crest of Lee's mountain; and that the floods of ice-water poured through these notches down Brier creek, southward into the flooded valley of the Susquehanna river at Berwick, where they deposited the extensive terrace-plain which covers that part of Columbia county.

Prof. White ascribes the formation of the two notches in Lee's mountain to this furious overflow; but I hesitate to subscribe to this opinion, because similar notches are numerous in and in fact charteristic of the unglaciated mountains of the Juniata river country. But it has always been a puzzling question why almost all the notches of Jack's, Stone, Tuscarora, and other mountains of central Pennsylvania are cut through the *southern* crest, and very few through the *northern* crest, of any of those split anticlinal mountains. The fact was noticed in making the State Geological Map in 1841, but has never been satisfactorily explained. There is, however, a fundamental difference between an *anticlinal* canoe prow, like those of the Buffalo mountains in Snyder and Union Counties, composed of two concentric pairs of crests, the outer pair produced by the *Medina* outcrop and the inner pair by the *Oneida* outcrop, with a high lune-shaped vale between, which must necessarily drain itself through one or more notches through one or more of the other crests—and a

synclinal canoe prow like that of the Huntington-Lee mountain in Columbia county, which has but the one pair of crests, and no lune-shaped vale. The formation of a notch is here extremely difficult to explain; and still more difficult the formation of two notches, not far apart, in the same crest. It is quite possible, then, that Prof. White's very picturesque explanation may be actually the true one; and that the ice-waters formed the eastern notch first; and then, after the ice-tongue had protruded itself past that notch and stopped it, a second notch was cut beyond the finally stationary point of the tongue. That the notches were cut in Lee's mountain instead of in Huntington mountain may be explained partly by the fact that the crest of Lee's mountain runs at an elevation above tide a little lower than that of Huntington mountain; and partly by the fact that the ice sheet must have been a greater barrier to drainage along the northern of the two mountains.

§18. *Glacial striæ*, scratches, and grooves are noted in this report at many points of the region back of the Moraine; that is, to the north-east of it. (See Index, under the word *Striæ*.) Their general direction is south-west, but they vary locally from S. 30° W. (page 120) to S. 80° W. (page 181.) They are boldly sculptured on the sandstones and conglomerates at all elevations, from 725′ (page 181) to 1275′ (page 172) above tide. (See tables on page 15.)

§19. *Glacial drift*, as a sheet of unstratified sand, gravel, and bowlders, covers the whole region back of the Moraine, and is finely exposed along the water courses. The thickness of this universal mantle of ice-borne trash, brought from the north, is about 50 feet; but where it is banked into the original hollows of the country, filling up ancient river valleys, it is much deeper. On Mehoopany creek, in Wyoming county, the top of the drift is more than 235 feet above the bed of the stream (page 137;) in Monroe township, Wyoming county, it rises to 100′ above the bed of the stream (page 150.)

Independent observers in other States have assumed 50 feet as about a fair general average thickness for the northern drift over the whole region back of the Moraine. If

this average be finally accepted, it must set at rest the vexed question of the eroding power of the ice-sheet; for, 50 feet of eroded trash carried forward by the ice-sheet can only represent 50 feet (or somewhat less) of mother rock in place. This is an insignificant proportion of the amount of strata (from the coal measures down to the crystalline series) which has been removed from the crust of the earth in the long process of sculpturing the valleys and plains of Pennsylvania and New York, the Great Lake basins, and the plain of Canada. Were the average thickness of the drift twice 50 feet, it would be equally true that the erosive power of the ice-sheet has been immensely overrated, and that what erosive power it had was exhausted in merely polishing off and puttying up the topography of the continent.

§20. The *post-glacial terraces* and *erratic bowlders* of the region are copiously described by Prof. White in this report. (See Index, under *Terraces*, *Bowlders*, &c.)

Outside, or to the south and west of the Moraine, the tops and slopes of the mountains and higher hills of Columbia, Montour, and Northumberland counties show no signs of the former presence of ice—no unstratified drift, no ice-scratches, no *kames* (formed in ice caverns by subglacial torrents.) But the whole country *below* the level of 800′, or 750′ above tide, is more or less covered with a *post-glacial* stratified deposit of *modified drift*, derived from the Moraine and from the *glacial drift* which covers the country behind it to the east and north.

These *post-glacial terrace deposits* are supposed by Prof. White to mark a *flooded river age*, beginning with that general rise of the thermometer all over the world which rapidly melted back the ice-sheet and left the continent in its present genial condition. The winter of the ice age was over; the summer burst upon the world; the mountains appeared again; the valleys were reëxcavated. Unimaginable floods poured southward without cessation along all the valleys, and spread out over the lowlands their burdens of Moraine stones, rounded and smoothed by the tumultuous waters. When quieter times came, the Susquehanna river and its affluent streams cut down through these post-

glacial deposits, as shown by the terraces which now border their banks. (See Index, under the word *Terraces.*)

Perhaps the most striking of these terraces are those along the West Branch Susquehanna, at the northern end of Northumberland county, standing at 20', 40', and 175' above the present river bed, (page 328.) Those at Sunbury rise 25', 55', 80', and 175' above the present river bed, (page 336.) As far south as Georgetown, near the Dauphin county line, the main terrace is 125' above river level, (page 373.)

Considering that the highest terrace in northern Northumberland (175' above river level) is 635' above tide; that *rounded* bowlders cover hill tops back of the river at 690' A. T. (page 330); that *rounded* bowlders occur 140' above Fishing creek, in Columbia county, *i. e.*, up to 700' and 720' A. T. (page 207); other drift reaching 800' A. T. on the ridge (page 256); that vast heaps of *rounded* bowlders from the Pocono and Pottsville conglomerate mountain-crests remain on the summit of a ridge in Franklin township, Columbia county, at 950' A. T.; while the highest limit of this kind of drift only reaches 800' A. T. along the slopes of the Chemung ridge through northern Montour and Northumberland counties;—it seems to me necessary to suppose some sort of submergence of the region beneath sea level, or what will amount to the same thing, a general rise of ocean level to 800', or 1000', A. T. This would flood all south-eastern Pennsylvania to within a few hundred feet of the crests of its mountains, and account for most of the terrace deposits in this region. Certain difficulties might arise in discussing upon this basis the 400' gravels, &c., of the tide water country. But such a submergence would go far towards explaining, for instance, the high rounded-bowlder plain in front of the Wind Gap in Northampton county. Upon the tide of such a submergence, floating ice might drop the angular bowlders of Pocono sandstone,* five feet in diameter, noticed by Mr. White on the summit of Montour ridge at 750' A. T. (page 263), and the angular bowlder of Catskill sandstone on the hills of

* If these be not Medina sandstone blocks covering mother rock.

Logan run in Rush township, Northumberland county, at 725′ A. T. mentioned on pages 352–3.

The *local drift* terraces of the Monongahela valley, and the rolled-northern-drift terraces of the Allegheny and upper Ohio river valley, limited upwards to 1075′ A. T. have recently received a pretty satisfactory solution by the Rev. Mr. Wright's discovery of a glacial ice-dam at Cincinnati, sufficient to make back-water to the height of at least 550′ above the river there, *i. e.*, to a level of nearly 1100′ A. T. But no such back-water submergence west of the Allegheny mountains is available for explaining the terraces of Middle or Eastern Pennsylvania, since the lowest divide, at the head of the Red Bank and Sandy in Jefferson county, is 1550′ A. T.;* and since some ice-dam or other barrier, (in fact many such), would be required to prevent outpour into the Atlantic. The Delaware water gap was certainly stopped up by ice; and perhaps the Lehigh water gap; but no traces of ice are visible at the Schuylkill, Swatara, and Susquehanna water gaps. Yet great deposits of *rounded bowlders* opposite Selinsgrove reach the height of 625′ A. T. (page 363); and between Milton and Muncy 800′ A. T. (page 326).

§21. *Buried river channels* appear in this as in preceding reports by Mr. White; and he gives interesting details of the old channel of the Susquehanna river underneath the Kingston flats, opposite Wilkes-Barre. Bore-holes through 210′ and 212′ of drift, struck the old river bed at 185′ and 180′ below the present river level; *i. e.*, at 340′ A. T., whereas the river level at Wilkes-Barre is now 525′ A. T. (See pages 24, 25.)

What renders the depth of this ancient channel of the river embarrassing, is the fact that a rock-dam lower down the river, at Bloomsburg, crosses its bed 450′ A. T. (pages 26, 303, 307, 350, 352,) and another near Sunbury, at 430′ A. T., apparently to the exclusion of any possible side channel. Even at the Dauphin county line the rocky bed of the Susquehanna is 385′ A. T.; *i. e.*, 45′ higher than the bed of the ancient channel at Wilkes-Barre. Did the

*See my preface to Report Q, p. xxxviii, 1878.

ancient river flow northward then into New York State? That were hardly possible, in view of the character of the Tunkhannock cañon, which would require for this purpose to be deepened at Tunkhannock about (580± — 340′ — 40′=) 280 feet; and at the New York State line about (780± — 340′ — 200′ =) 640 feet, which is utterly incredible. (See page 6.)

I think we are shut up to the explanation of subglacial erosion—rivers beneath the ice-sheet, charged with angular drift materials, ploughing deep valley-grooves in the softer coal measures as far as Nanticoke, and in the soft red shale from Nanticoke to Shickshinny.*

The general deepening of the exceedingly yielding Marcellus outcrops, and the subsequent refilling of the troughs by rolled drift, is described on pages 78, 125, 193, 243, 294, and 306.

And here a very important fact arises to show the dependence of capital interests on geological theories. The Lower Helderberg limestone is the great dependence of the region. Wherever it is not seen standing as a ridge above the surface it is quarried for farm and furnace use. Where it is not so seen the people think that it does not exist, and do not look for it. But a geological study of glacial erosion easily proves that it does exist; that the deep channels made in the Marcellus slate next to it has worn its outcrop down beneath the surface, while the same rolled drift which again filled up those channels also covered up the eroded outcrop of the limestone. If holes were bored through the drift they would surely strike the limestone. (See page 233.)

§22. *A geological map* in two sheets accompanies this report. On one sheet are represented the three counties of Wyoming, Lackawanna, and Luzerne; on the other the three counties of Columbia, Montour, and Northumberland.

In the construction of this geological map, wall and atlas maps of various authority and date have been used; some more accurate than others; but none of them quite reliable.

* The great buried depressions at Huntingdon, on the Juniata river, seems to demand some other explanation. But are we sure that Jack's Narrows gap was not stopped up by local ice for a certain length of time during the maximum cold of the ice age?

The geological outcrops have been drawn across the region from point to point wherever the rocks appear upon the streams and roads; with breadths sometimes observed, sometimes calculated from the dips. The map is therefore useful only as an illustration of the geological structure of the region, and cannot be a safe guide to minute local exploration. In fact, no such guide can be afforded until the Legislature orders a trigonometrical survey of the State to be made. Such a trigonometrical survey is the only true basis of—is in fact a necessary condition for—the production of really correct township and county maps; and the longer such a survey is delayed the greater becomes the confusion of our maps.

In the present instance, a geologist could not be expected to produce, in one field season, a geological map of six counties which could sustain without reproach minute local criticism. But such a map as is here presented performs the useful, in fact indispensable service, of directing all observers along well defined lines of outcrops, clearly distinguished from each other by colors, and near enough in their true positions to prevent serious mistakes of observation.

A part of the map of which I stand much in doubt, is in northern Northumberland county. The crumpling of the Upper Silurian country east of Watertown and Milton, has caused the blue belt of Lower Helderburg limestone (with its numerous quarries) to zigzag over the surface in an irregular manner difficult to portray, unless a much greater amount of local field work is expended upon it. A good geologist might very well spend an entire field season in properly mapping this small area. Certainly it is not properly represented on our map, as future revisions will show.

The anthracite coal fields are represented on the map *provisionally.* When the Anthracite Survey sheets are finished, numerous corrections can be made.

In the Lehigh coal region, the situations of the coal basins are pretty well fixed, and the *Pottsville conglomerate* outcrop (around the coal) can be represented with a fair approach to truth.

But in the Wilkes-Barre coal field the southern border

of Conglomerate is not yet well made out. Anticlinal prongs of it project into the coal; isolated anticlinal patches of it are suspected to exist inside the coal; and the upper limit line of the Conglomerate (or inside edge of the pale grey color on the map) is extremely irregular. No true representation of it can be given until the work of the Survey in this Northern coal field has gone much further. I might have compiled the outline of the *top of the Conglomerate* from the Anthracite Map of 1858,* and other sources, but it would have been dangerously incorrect.

The upper Lehigh river country is extremely defective. It will be many years, I fear, before a really good map of that wild region will be made. There is very little inducement to survey it minutely, and the county maps are extraordinarily conflicting.

The Wyoming county part of the map is about as bad as it could be; but perhaps no worse than the published maps of most of Susquehanna and all of Wayne county; certainly no worse than the utterly unreliable published maps of Sullivan county.

This north-eastern corner of Pennsylvania is an elevated, rough and woody region, nearly 5,000 square miles in area, the maps of which are all mere caricatures.

To map this region *properly* would require an appropriation of at least $150,000, for surveys extending through at least ten years.

The land tract surveys are extremely incorrect and conflicting, streams being left out or put in, and connected, almost at random. Many of the tract lines have never been run on the ground, but have been drawn in the office. In any given case where a stream is shown upon the map as crossing a land line, there is no guarantee that the line was actually run; but a probability that the stream was sketched by fancy and the land line drawn independently across it.

Very few private surveys of a careful and precise character were ever made in all this region; and when such pri-

* In Atlas to H. D. Rogers' Geol. of Pa., Final Report of First Survey. This Northern coal field map was chiefly the work of Assistant Geologist Alexander McKinley, in 1840, 1841.

vate surveys were repeated on certain tracts supposed to contain coal, the private maps of these surveys disagree; important streams appear on one map which are omitted from another; and in no case does the same stream have the same course on two separate maps.

It is simply impossible to represent the geology of a region like the Mehoopeny where the rocks lie almost flat without *extra good* maps. A similar instance was presented by McKean county, with its flat rocks and isolated mountain top coal areas. The survey of McKean county received two years' work of the Survey because a completely revised map of the county had to be made by actual survey to connect and correct local maps before the geological coloring of the coal areas could be laid in.

Col. Ricketts' connected map, and Mr. Daddow's map and report of the Forkston and Mehoopeny coal region are in Mr. Ashburner's hands, and will be used in a future report; but I make a *provisional use of them* in the geological map which accompanies this report.

§23. *The Sections on page plates* scattered through the report are mere graphic reproductions of Prof. White's textual sections. I have drawn most of them myself, in my own way, to make the reading of the report easier; they are therefore of various kinds, to suit the subjects which present themselves in turn on the pages of the report. I should have gladly added more, in the form of *transverse structure-sections*, had my other occupations permitted. But the general simplicity of the structure of the region, and the copious quotation of dips which Mr. White has made, render the absence of this class of sections less objectionable. Such sections will appear in the final report on the whole State.

§24. *The palæontology* of this report requires the closest consideration, and presents some difficulties of considerable magnitude. I have, therefore, submitted the proof-sheets to our highest authority, Prof. James Hall of Albany, and will try to place in a clear light the principal points at which a conflict of opinion may arise; that is, certain features of our Pennsylvania section which suggest, rightly

or wrongly, its divergence from the character of the New York section.

The questions which Mr. Hall asks are :—*a.* Is the lowest fish bed a proper horizon to select for the base of the *Catskill* formation (see page 54), seeing that there is a bed in the *Upper Chemung* of New York State, full of fish remains, which could not be better described than by Mr. White's description of bed 38, Sect. 9, page 57,—"Sandstone with fish bones, vegetable fragments, and pebbles of slate."

Mr. Hall would certainly prefer to limit the *Catskill* (as Mr. White suggests, p. 59) at bed 22; because *grammysia elliptica* (if that *be* the fossil found in bed 23), is certainly confined to the *Chemung;* because *Pteronites chemungensis* (? in bed 35) is also a typical *Chemung* form; and because the combination of thin layers of hard bluish-green shale, with *Spirifers* and *crinoids in a fragmentary condition* is a combination characteristic of the rocks beneath the base of the *Catskill* formation *i. e.*, in the top rocks of the Chemung, of New York; the *Spirifers* in the cornstone series being never found whole, as if living *in situ.*

Nor can the *Holoptychius* form in bed 54 at the base of the section be accepted in the argument until its generic character be placed beyond cavil.

b. How is it possible to credit such a topsy-turvy appearance of the three species of *Spirifera*, which, outside of Pennsylvania, have been found (1) never in any but Chemung rocks; (2) confined each to its own horizon; and (3) always in a fixed order from above downwards, thus :—

Spirifer disjuncta horizon, (*S. dj.*)

Spirifer mesocostalis horizon, (*S. mc.*)

Spirifer mesostrialis horizon, (*S. ms.*)

It is, therefore, astonishing to see *S. dj.* and *S. ms.* mixed together "in large numbers" in bed 31, Sect. 9, (page 57;) —to see *S. dj.* in bed 10, Sect. 11, (page 64,) and *S. ms.* in bed 13, only 20′ lower down;—to see all three mixed together in bed 9, Sect. 12, (page 68);—but especially to see them alternating in the following amazing manner in Sect. 13, (page 69):—

S. ms. in bed 9.
Interval of 250′.
S. dj. in bed 13.
Interval of 180′.
S. ms. in bed 17.
Interval of 215′.
S. dj. in bed 26.
Interval of 255′.
S. dj. + *S. mc.* in bed 30 (a possible conjunction.)
Interval of 127′.
S. dj. + *S. ms.* in bed 36 (an impossible? conjunction.)
Interval of 100′.
S. mc. + *S. ms.* in bed 38 (which is, however, 125′ thick.)
Interval of 360′.
S. mc., in bed 41.
Interval of 200′, down to the top of the *Genesee slate.*

In fact, Prof. Hall has never seen any two of the three species co-existing in the same stratum, or at the same horizon, nor outside the limits of the typical Chemung. He would not be surprised if *S. mc.* were found to ascend high enough above its proper horizon to mingle with *S. dj.* But he cannot comprehend how *S. dj.* and *S. ms.* should be found together. (See p. 65, paragraph 2.)

The variations of outward form in *S. dj.* are very numerous and misleading, and he has given a whole page full of figures, in Pal. N. Y. Vol. IV, to illustrate these variations. But the internal impressions are unmistakable. A hand specimen was submitted to him as crowded with *S. dj.* and *S. ms. commingled*, but inspection convinced him that they were all variations of *S. dj.* and that *S. ms.* was absent.

The great fossiliferous Stony Brook bed 9 (Sect. 12, page 68,) containing all three forms, *S. dj.*, *S. mc.*, and *S. ms.*, is 55 feet thick; and Mr. Hall regards its description as quite typical of the *Middle Chemung*, which contains the three species of Spirifer, but in their separate horizons.

Considering the progressive enlargement of the New York formations southward into Pennsylvania, it looks as if the Upper Chemung of this report might correspond to the Middle Chemung of New York; and, therefore, that

our transition series (*IX–VIII*) *Catskill-Chemung*, and perhaps part of our *Catskill*, might better be called *Upper Chemung.* In that case Mr. White's *Upper Chemung* would become *Middle Chemung.*

The *red beds* of the *Catskill-Chemung* part of the series so interlock with and change into *grey beds* going west that they can be of no practical utility in fixing the limits of the formations, or deciding questions of nomenclature. Prof. White considers his *Catskill-Chemung* group identical with the interval between Prof. Stevenson's "Upper and Lower Chemung conglomerates," although no red beds appear in this interval.

Avicula tricostata is abundant above the *Stony Brook* (*Chemung*) *beds* (page 73, 366, 367); *Avicula bellistriata* in *Hamilton Shales; Avicula leptonata* in the Clinton ore bed. (See Index of fossils.) Prof. Hall has recently discovered that the three different *Chemung* conglomerates at Panama, Salamanca, &c., in Western New York, hold abundantly and *respectively* three distinct species of *Avicula*, which he will refer to a new genus; and he hopes that this differentiation may hereafter assist us in our classification of the *Chemung* along its numerous outcrops in Middle Pennsylvania.

c. Are not the assertions respecting the great upward *range* of the eight fossils named on page 65 (four of which are marked doubtful) embarrassing to our present knowledge of Devonian and Carboniferous Palæontology?

d. Orthis tulliensis, in bed 41, Sect. 13, page 70, has certainly never before been seen in the *Chemung* 200′ above the *Genesee* (*i. e.*, 300′ above the Tully limestone;) nor in the company of *Spir. mesocostalis.*

e. Chonetes setigerus in Stony Brook beds, No. 6, Sect. 14 (page 71, 72,) is a Hamilton species, but has been seen in the Chemung. It is extraordinary enough to see this Hamilton fossil 2000′ above the top of the Hamilton rocks, but our wonder is increased by seeing it in company with *Sp. disjuncta*, *Sp. mesocostalis*, and *Orthis tioga*, (not *tulliensis*.)

g. Halycites catenulatus is found by Mr. White quite

out of its natural place; at one locality only, it is true; but in such abundance as to "make up a large proportion of the 20′ of beds through which it is found," (page 97, ¶ 1.)

"Sir W. E. Logan recognizes it as low as the *Trenton limestone;* and I have seen a form or variety of the same in the *Hudson River group* of Green Bay; but no one has ever before found it above the *Niagara.*"*

Whatever may be the difficulty of distinguishing *Sp. disjuncta* from *Sp. mesostrialis,—Orthis tioga* from *O. tulliensis*, &c., it is quite impossible for anyone to mistake *Halycites catenulatus*, the characteristic form of the *Niagara limestone*, all over the United States and Canada, and also of the corresponding *Wenlock* of Europe.

Therefore, its appearance in abundance under the *Stromatopora bed* of the *Stormville limestone group* in the *Lower Helderburg* formation is a very serious matter for Pennsylvanian geology, giving rise to many questions of wide reaching importance; to understand which, the accompanying scheme of New York formations will be useful.†

f. Spirifer arenosa has always been accounted peculiarly characteristic of the *Oriskany.*

On the other hand, *S. macropleura* has never been found in the *Oriskany* of New York, but always lower down.

On section 20, page 88, this order is reversed, and both forms are placed *beneath the Oriskany:—S. m.* in the *Stormville shales;* and *S. a.* in the "Sandblock" layer, 4′ thick, at the bottom of the 100′ of shales, and immediately overlying the uppermost layer of *Helderberg limestone.* On page 95, Prof. White says: "The sandy portions [of the Sand Block] frequently contain a large coarse *Spirifer* which I could not distinguish from *S. arenosa* of the *Oriskany.*" Prof. Hall is unwilling to believe it *S. arenosa;* and thinks that the "*S. macropleura*" in the overlying shales, may be some broad ribbed *Spirifer* of the *Oriskany. S. macropleura* is the earliest *Spirifer* which shows ribs in the medial series, and it recurs nearly unchanged in the *subcarboriferous Chester limestone* of the West.

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* Letter of J. Hall, Sept. 3, 1883. † See page xxiv.

ORISKANY. (Often thinning away to nothing.)

L. HELDERBERG.

U. Pentamerus (the smooth *pseudogaleatus*) *limestone.**
Delthyrus shaly limestone.
L. Pentamerus (plicated *galeatus*) *limestone.*
Stromatopora† *bed* (4′ to 6′,) persistent through Albany and Scoharie counties.

Tentaculite limestone, massive, dark; making black marble.

ONONDAGA OR SALINA.‡

Upper hard bed; the *Water-lime* proper: magnesian.
Middle salt-bearing marls.
Lower soft red and grey shales, with magnesian limestones.

NIAGARA. (In Central N. Y.)‖

Upper limestone portion.§
Lower shaly portion.

CLINTON.

Upper sandstone beds.
Upper green shales, with some iron ore.
Lower (*Pentamerus oblongus*¶) limestone beds.
Lower green shales, with limestone and iron ore beds.

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* The *Scutella* (*encrinal*) limestone layers occur in the top of this division.

† No specific names have been given as yet to these *Stromatopora* forms. They are now being studied by Prof. Hall for publication. The name *S. concentrica* used in this report is the name of a Europeon Devonian species, and ought not to be accepted for our Stromatopora beds until a microscopic study shall be made.

‡ The name Onondaga was proposed by Vanuxem because the salt group is greatly exposed there, while in Salina county there are no exposures. Prof. Dana changed the original name for the purpose of shortening it, and on account of the salt deposits.

§ East of the middle of the State greatly quarried as a compact dark limestone, *with few fossils*, *Leperditia* being the most conspicuous.

‖ In eastern New York the whole Niagara formation is only from 4′ to 12′ thick, an irregular mass of corals of three forms (*Halycites catenulata*, *Favosites niagarensis*, and *Columbaria*) in large masses, associated with *Stromatopora foliculata*.

¶ In western Canada this fossil rises in the series so far as to be found near the upper part of the *Niagara limestone*. There the Niagara and Clinton limestones come together without the intervention of Niagara or Clinton shales. All the limestones are in one mass above, and all the shales in a mass below.

If, as has hitherto been supposed, any stratum holding *Halycites catenulata* must necessarily belong to the *Niagara series*, which everywhere *underlies* the *Salina*, how does it happen that in Prof. White's section 67 (page 244, 245) a great deposit of *H. c.* appears above the *Bossardville* member of the *Helderberg* series, which *overlies* the *Salina*?

If the *Salina*, with its triple division 1176′ thick, be here rightly interposed, then the *Halycites bed* above it is, at this one locality in Pennsylvania, nearly 1500 feet higher in the order of rocks than at any other locality between the Hudson and the Mississippi where it has been hitherto observed; while, what is perhaps of equal importance, no *Halycites* has been seen by Prof. White anywhere in his district *underlying* the *Salina*; *i. e.*, in the place where the *Niagara* ought to be.

To this must be added the remarkable fact that no mention of *Pentamerus*, whether *pseudo-galeatus*, *galeatus*, or *oblongus*; *i. e.*, either in the Helderberg or Clinton rocks, occurs in the whole course of the report. If *Pentamerus* be absent, and *Halycites*, present a New York or Canadian geologist would argue that the *Stormville and Bossardville series* could not be *Helderberg*, and must be *Niagara*.

This supposition, however, is quite set aside by the evident existence of the whole *Salina* formation in its proper place lower down. Yet the *Bastard limestone*, impure and filled with crinoidal fragments and corals, with *Halycites*, exactly corresponds to the description of the *Niagara* of eastern New York.

With the exception of *Halycites catenulata*, all the other fossils (mentioned on page 89) might belong to any horizon; *i. e.*, considering the possibility of *Favosites niagarensis* being mistaken for *Favosites helderbergiæ*. But Prof. Hall has given himself infinite trouble to obtain the data on which the proof rests, that *H. catenulata never* occurs except in *Niagara* and *Clinton* rocks.

I would remark, in conclusion, that the immense collections of Prof. Hall, studied for forty years with preëminent ability, have been made chiefly along the northern outcrops of the formations through New York, Canada West, and the

north-western States; and, therefore, may not furnish absolutely unchangeable canons of classification for the southern and much thicker outcrops of the same formations extending for an equal distance through New Jersey, Pennsylvania, and the Southern Atlantic States. It seems quite possible that some of the northern forms may be wholly wanting in the south; or may be wanting at their proper horizons, and yet discoverable at higher or lower horizons in the series; or that specific variations of a genus may arrange themselves vertically or stratigraphically in the north, and horizontally or geographically in the south; or vice versa.

But inasmuch as a well authenticated *subversion* of specific types in vertical range must cast the most injurious suspicions of artificiality upon the long and well established canon of palæontology, that every species has varied in the lapse of time, *i. e.*, in vertical range, under the influence of yet unknown causes, but according to perfectly (although not easily) distinguishable external and internal organic markings,—it would be rash to accept *any* observer's specific determinations in opposition to this canon, no matter how conscientious and able that observer may be, until such determinations have been submitted to repeated criticism; and until still more punctilious examinations of the series of rock layers holding such uncanonical forms shall have been made by other geologists.

The startling fossil species of this report will therefore be regarded by the palæontological reader as only *provisionally verified;* while they must certainly stimulate American geologists to a closer study—and especially to a microscopic study—of several of our so considered plainest and least ambiguous forms.

Respectfully submitted,

J. P. LESLEY.

1008 Clinton Street,
PHILADELPHIA, *August 31, 1883.*

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G⁷.

List of figured sections.

REPORT OF PROGRESS, G⁷.
1882.

REPORT OF A GEOLOGICAL SURVEY

OF THE

NORTH BRANCH SUSQUEHANNA COUNTRY.

BY

I. C. WHITE.

CHAPTER I.

General Description.

The region reported on in the present volume embraces an area of nearly 2000 square miles, and includes the following counties and parts of counties: Wyoming, Lackawanna north-west of the Lackawanna river, Luzerne north of the Susquehanna river, Columbia, Montour, and the greater part of Northumberland.

The area thus inclosed extends from the south line of Susquehanna county south-westward, along the North Susquehanna river to its junction with the West Branch, and thence southward for 20 miles along the main Susquehanna; making an air-line distance of more than 100 miles from the north-east corner on Wayne county, to the extreme south-western point on Dauphin county.

The portion of the above area underlaid by the *Coal*

Measures is not touched upon in this volume, since the Anthracite Survey, in charge of Mr. Ashburner, will report on that.

Drainage.

The Susquehanna river carries to the sea the entire drainage of the district, its North Branch being the principal water-way for all except the extreme western portion.

This North Branch enters the district from Bradford county at the north-west corner of Wyoming, and flows diagonally across the latter county to its south-east corner, just south from which it cuts through the northern rim of the Lackawanna coal basin, and then veering around at almost a right angle, flows through the Wyoming coal basin, nearly S. 70° W. to Shickshinny, where, turning southward it cuts squarely across its western end, and keeps on south about six miles. Here coming into the soft shales of the *Hamilton series* it again veers westward (S. 80° W.) along the strike of these beds for a distance of 20 miles, to Rupert. Here turning southward again, it cuts through a high ridge of Chemung rocks into the Catskill red shales of the Northumberland syncline, down which it meanders, with several large bends both north and south, to its junction with the West Branch, at Northumberland, from which point the main stream flows southward directly across some of the grandest anticlinals and synclinals in the State.

The West Susquehanna flows along the western boundary of Northumberland county and drains the northern half of that area together with a considerable portion of northern Montour county.

Its course is nearly due south squarely across the anticlinals and synclinals which traverse Union county and are exhibited in the spurs and ravines of the Buffalo and Jack's mountains.

The North Susquehanna receives the following principal tributaries within the district, beginning at the north in Wyoming county.

Meshoppen creek enters Wyoming from Susquehanna county and drains a small area of northern Wyoming into the Susquehanna at the village of Meshoppen.

Mehoopany creek pours a large volume of water into the west bank of this river only 3 miles below Meshoppen. It rises near the south-western corner of Wyoming county, and flows northward to Forkston, where, after receiving a large branch from the west, it veers eastward and flows a little north of east to its mouth. This stream drains a large portion of the mountain regions of Wyoming.

Bowman's creek rises in the north-western corner of Luzerne, on the north slope of the North mountain, and following north-eastward through southern Wyoming, nearly parallel to Mehoopany creek, carries a large volume of water to the North Susquehanna just below Tunkhannock.

Tunkhannock creek drains north-eastern Wyoming, and north-west Lackawanna. It flows nearly opposite to the general direction of Bowman's creek, and empties one mile above the latter.

Lackawanna river flows south-westward down the center of the Lackawanna (Wyoming) coal basin, and joins the North Susquehanna near Pittston, where the latter stream veers suddenly westward.

The tributaries which drain north Luzerne are nearly all small streams which rise near the county line and flow southward, reaching the North Susquehanna through "notches" or gaps in the mountain which makes the northern rim of the Wyoming coal basin. Among these, the principal are Harvey, Hunlock and Shickshinny creeks.

Big and Little Wapwallopen flow west through central Luzerne into the North Susquehanna where that stream turns westward again, six miles south from Shickshinny.

Nescopeck creek drains the most of southern Luzerne; its general course is westward until within a few miles of its mouth, when it veers suddenly northward, and cutting a deep, narrow gap through the Nescopeck mountain, empties into the North Susquehanna opposite Berwick, near the line between Luzerne and Columbia counties.

Fishing creek, with its tributaries, *Huntington*, *Green*, and *Little Fishing*, drains practically all of Columbia county north of the river.

The main branch of Fishing creek takes its rise on the summit of North Mountain, in Sullivan county, at an elevation of nearly 2,200′ above the sea. Its general course is southward directly across the rocks to its mouth at Rupert.

Huntington creek drains the north-western portion of Luzerne southward to Huntington mountain, along the base of which it flows, westward, until it empties into Fishing creek in Columbia county.

Catawissa and *Roaring creeks* drain south Columbia, northward.

Catawissa creek flows out of Catawissa valley through a gap in the Nescopeck mountain and enters the river at Catawissa.

Roaring creek heads between the Big and Little mountains; cuts through Little mountain; traverses, northward, Roaring creek valley; and enters the river at the line between Columbia and Montour counties, 4 miles below Catawissa.

Chillisquaque and *Mahoning creeks* drain Montour county, the latter emptying into the North Susquehanna at Danville through a breach in Montour ridge, while the former goes south-westward to the West Susquehanna, at the western end of Montour ridge.

With the exception of Chillisquaque creek all the other streams of northern Northumberland county are small, and drain insignificant areas.

Shamokin, *Mahanoy*, and *Mahantongo creeks* drain southern Northumberland, or that part of the county lying south from the North Susquehanna river.

Topography.

The surface contour of this district is extremely varied.

In Wyoming county the rocks dip so gently that they are practically horizontal; and when the *Pocono beds* are absent, the *Catskill rocks* (which cover more than two thirds of its area) have been eroded into a series of rounded hills, with comparatively gentle slopes; except along the larger streams, where they become quite steep, and in some cases nearly vertical. These *Catskill hills* seldom rise to an elevation greater than 1200′ A. T.

But the case is quite different where a coping of *Pocono*, or *Catskill-Pocono beds* still covers the softer *Catskill rocks;* for then the surface slopes rapidly up to an elevation of 2100–2200′ A. T. all over western Wyoming; and extends, as the great wall of North Mountain, south-westward, through north-western Luzerne, northern Columbia, and southern Lycoming, nearly to the West Susquehanna river.

Miller's Mountain, just below Tunkhannock, is an isolated peak, capped with the hard sandstones of the *Catskill-Pocono*; it rises to an elevation of nearly 1600′ above the Susquehanna river which washes its base, and about 1000′ above any of the surrounding *Catskill hills*.

Toward the western boundary of Wyoming the *Pocono beds* spread in a broad sheet at an elevation of 2000–2100′ A. T. broken only by deep gorges cut down by the headwaters of Mehoopany and Bowman's creeks. This region extends westward into Sullivan county, and is one of the wildest portions of the State; much of it covered with primeval forests of pine and hemlock, through which not a single road leads, and the larger wild animals (Bear, Deer, and Panther) are the only tenants.

In western Luzerne, Columbia, Montour and Northumberland counties, where the dip of the rocks is rapid, the general topography is closely connected with the geological structure; there being mountains wherever the *Pocono* or *Pottsville conglomerates* are found; low hills over the *Catskill* and *Chemung* area; and valleys (except in south Northumberland) wherever the *Hamilton*, *Lower Helderberg*, or *Salina* extend.

The *Oriskany* and *Clinton* outcrops usually make ridges.

Levels Above Tide.

The descent of the Susquehanna river through the district is shown by the following tables of elevations for the stations on the Lehigh valley, the Delaware, Lackawanna and Western, and the Northern Central railroads, given in Report N, Tables 74, 92, and 110.

Stations.	*Miles from New York.*	*A. T.*
Waverly (River here 750' A. T.),	265	830'
Sayre junction,	263	774'
Athens bridge,	259	779'
Ulster,	248	743'
Towanda (River 700'),	244	738'
Wysauking,	240	718'.5
Standing Stone,	236	702'
Rumnerfield,	233	696'
Frenchtown,	229	690'
Wyalnsing,	217	674'
Laceyville,	214	658'
Black Walnut,	211	649'
Meshoppen (River 609'),	206	644'
Mehoopany (River 600'),	203	634'.5
Vosburg,	196	615'.5
Tunkhannock,	188	611'
Legrange,	184	598'
McKunes,	181	598'
Falls,	177	587'
Ransom,	—	579'
Lackawanna Junction (River 535'),	170	570'

From this point the D. L. & W. R. R. (Bloomsburg Branch) gives the following as corrected by Allen and Ames (see Report N, Table 92):

Stations.	*Miles from Northumberland.*	*A. T.*
Pittston,	71	572'
Top of rail at west end of bridge across Susquehanna river,	—	571'
West Pittston,	70	579'
Wyoming,	68	588'
Maltby,	66	558'
Bennett,	—	553'
Kingston,	63	562'
Plymouth Junction,	61	543'
Plymouth,	60	535'
Avondale,	58	530'
Nanticoke (River 515'),	56	538'
Hunlock's creek,	53	531'
Shickshinny,	48	521'
Hick's Ferry (River 485')	42	521'
Beach Haven,	39	530'
Berwick (River 475'),	36	504½'
Brier Creek,	33	501½'
Willow Grove,	—	516'
Lime Ridge (River 457'),	29½	509'

Espy,	26	490′
Bloomsburg,	24	489′
Rupert,	22	482′
Catawissa,..	20	472½′
Danville,.	12	457½′
Chulasky,..	9	455′
Cameron,	7	458′
Northumberland,	0	452′
Susquehanna river at Northumberland,	—	429½′

rom this point southward the Northern Central profile gives the following, beginning at Sunbury, two miles south from Northumberland, (see Report N, Table 110 :)

Stations.	*Miles.*	*A. T.*
Sunbury,	0	444′
Selinsgrove Junction,	5	438½′
Fisher's Ferry,	7	439′
Trevorton Junction,	11½	430′
Georgetown,	16½	416′
Mohantongo, (south line of district,)	20	405′
Liverpool,	24	396′
Millersburg,	27	397′
Halifax,	32½	381′
104 Mile post,		376′
Powell's creek, N. end of bridge,		371′
Clark's Ferry,	39	366′
Dauphin,	45½	350′
Marysville, W. end of bridge,	47	349′
Bridgeport, (opposite Harrisburg,)	54½	354½′
Susquehanna river at Harrisburg,		290′

Since these RRs follow the bends in the river quite closely between Waverly and Harrisburg the distance as measured on them (220 miles) will not differ much from the true distance by the meanders of the stream.

The Susquehanna river therefore falls (750′—290′) 460′ in 220 miles, or about 25 inches to the mile.*

The descent of the West Branch Susquehanna river is shown by the elevations on the Philadelphia and Erie railroad, (see Report N, Table 130):

[* The fall of the river is greatest in reaches *at right angles to the strike* of the rocks :—from Waverly to Pittston, 27″ per mile ; from Northumberland to Harrisburg, 28″ ; but from Pittston to Northumberland, *along the strike*, only 18″.]

Stations.	*Miles from Sunbury.*	*A. T.*
Williamsport,	40	527′
Muncy,	28	520′
Montgomery, (north line of Northumberland Co.,)	24	490′
Dewart,	19	486′
Watsontown,	17	482′
Milton,	18	473′
" Crossing of Catawissa RR.,	12	469′
Montandon,	9	462′
Northumberland,	2	454′
Sunbury,	0	444′

Surface of water at Williamsport 498′ A. T.

Surface of water at Northumberland before Shamokin dam was built, 423′ A. T.

Fall of water in 38 miles (498′–423′) 75′ or nearly 2 feet to the mile.

The Catawissa and Williamsport R. R., a branch of the Reading R. R. system, descends the West Susquehanna to Milton, where crossing to its east bank, it goes eastward along the Hamilton shale valley to Mahoning creek; through the gap of which it passes to the south side of Montour ridge at Danville; then, turning east, it follows the strike of Hamilton beds in an old buried river channel to the West Susquehanna at Rupert; here it crosses to the east side of that river, and (two miles below) ascends Catawissa creek into Schuylkill county. The profile of the country along this line is as follows, (see Report N, Table 53:)

Stations.	*Miles.*	*A. T.*
Williamsport,	0	521′
Montoursville,	4	525′
Hall's,	9½	513′
Muncy,	12¼	495′
Seager's,	—	512′
Montgomery,	17½	486′
" Crossing of P. & E. RR.,	—	491′
Allenwood,	22	482′
White Deer,	24	476′
New Columbia,	27	477′
Milton (W. Susq. R. here 436′)	29	465′
" P. & E. crossing,	—	470′
Pottsgrove,	33	489′
Mooresburg,	38	618′

Waterman & Beaver's crossing,	—	483·
Danville,	45	494'
[Summit of old valley, (I. C. White,)	49	615']
Rupert,	52	495·
Catawissa,	54	477'
Crossing Dan. Haz. & Wilks. RR.,	—	478'
South end of Mainville Bridge,	60½	673'
McCauley,	63	759'
Shuman's Tunnel,	—	803'
Beaver Valley water tank,	68	925'
Rarig's,	—	1040'
Ferndale,	—	1095'
Ringtown,	—	1130'
Kreb's,	—	1225'
Brandonville,	80½	1285'
Girard Manor,	85	1408'
South end of Summit Tunnel,	—	1542'
Summit Station,	89	1537'
Quakake,	92	1353'
Tamanend Junction N. J. C. R. R.,	—	1305'
Barnesville,	95½	1106,
Mintzer's,	—	964'
Tamaqua,	—	808'

From Sunbury up Shamokin creek to the Shamokin coal field in Northumberland county, the following are elevations of stations on the Shamokin Branch, N. C. R. R., (see Report N, Table 127:

	Miles.	*A. T.*
Sunbury, Junction with N. C. RR.,	0	442'
Snydertown,	7	497·
Shamokin,	18	738'
Lancaster Br. Junction,	—	831'
Mount Carmel,	26	1054'
End of Road,		1090'

The Mahanoy and Shamokin branch of the Reading railroad, leaves the Northern Central at Trevorton Junction, or Herndon station, and ascends Mahanoy creek through the southern portion of Northumberland county into the Shamokin coal field. It exhibits the following profile, according to Report N, Table 57:

Stations.	*Miles.*	*A. T.*
Herndon (Treverton Junction),	0	431'
Trevorton Colliery,	13½	768'
Shamokin,	21	738'

Greenback Colliery,		909'
Locust Gap Junction,	$29\frac{1}{2}$	1037'
Head of Big Mine Run Plane,	—	1283'
Shenandoah City,	—	1252'
Girardville,	—	1021'
Cuyler Collery,	—	1368'
Preston Colliery No. 1,	—	1098'
Coal Ridge Colliery No. 2,	—	1139'
Montelier's Colliery,	—	1080'
Locust Summit,	34	1246'
Benjamin Franklin Colliery,	—	1088'
Keystone,	—	1038'
Ashland Summit,	—	1168'
Ashland,	38	859'
New Boston Colliery,	—	1528'
St. Nicholas Colliery,	—	1168'
Foot of Mahanoy Plane,	—	1132'
Head of Mahanoy Plane,	—	1485
Head of grade south side of Broad Mountain summit,		1479'

The descent of the Lackawanna river south-westward from the north-eastern point of Lackawanna county is shown by the following elevations on the Jefferson Branch of the Erie; on the Delaware and Hudson; and on the Delaware, Lackawanna and Western railroads. (See Report N, Tables 97, 93, 88.)

Stations	*Miles.*	*A. T.*		
Ararat Summit,	0	2023'		
Herrick,	6	1803'		
Uniondale,	8	1693'		
Forest City, (Lackawanna Co. line,)	14	1481'		
Carbondale,	19	1079'	1086'*	
Jermyn,	26		968'	
Archbald,	27		965'	
Olyphant,	30		807'	
Providence, (level of Lackawanna.)	33		700'	
Scranton,	35			740'
Bellevue,	$36\frac{1}{2}$			723'
Taylorville,	38			683'
Lackawanna,	40			637'
Crossing Pleasant Valley Branch,	—			583'
Pittston Junction,	44			572'
Lackawanna river at its mouth,				535'

The main line of the D. L. & W. RR. crosses Lackawanna county, and the eastern portion of Wyoming, ex-

[* This level of Carbondale is given differently by the two lines of surveys.]

hibiting the following elevations on its profile from Scranton northward. (See Report N, Table 90.)

Stations.	*Miles.*	*A. T.*
Scranton,	0	740′
Clark's Summit,	7¼	1239′
Abington,	10¼	1055′
Factoryville,	15½	917′
Tunnel,	17½	963′
Nicholson,	21½	766′
Tunkhannock creek here at mouth of Martin's,		700′
Foster, (in Susquehanna county,)	27¼	890′
Oakley's, (in Susquehanna county,)	29¾	942′
Montrose Depot, (in Susquehanna county,)	34¾	1050′
Summit cut at head of Salt Lick creek, (Bar.,)	40	1150′

The Montrose Narrow Guage railroad shows the following elevations: (see Report N, Table 79.)

Stations.	*Miles.*	*A. T.*
Tunkhannock,	0	611′
Marcy,	—	965′
Lemon,	—	1041′
Avery,		979′
Meshoppen creek (north line of Wyoming Co.,)		933′
Lynn, (in Susquehanna Co.,)	9	1032′
Springdale,	14	1257′
Tylerville,	—	1400′
Dimmock,	17	1507′
Hunter's,	—	1547′
Coal's,	—	1547′
Allenville,	—	1649′
Montrose,	28	1656′
Summit of hills here,	(Bar.)	1850′

The Wyoming Branch of the Pennsylvania canal descends the North Susquehanna river to Northumberland and the elevations along it, as determined by Mr. Chas. W. Ames in June, 1877, are as follows, (see Report N, Table 119:)

Commencing at Pittston.	*A. T.*
Surface of water in canal at Lackawanna junction, ... (557,69, say)	558′
" " above Lock No. 13, (near Port Blanchard,)	552′
" " " " No. 12, at Plainsville,	548′
" " " " No. 11, at Wilkes-Barre,	543′
" " below " " at "	534′
" " " " No. 10, 2 miles below Wilkes-Barre,	524′

Top of coping, south wall Lock No. 9, opposite Plymouth,			525'
Surface of water in Nanticoke Dam,	. . . .	(514.76)	515'
" " below Lock No. 8, Nanticoke,	. . . . .		513'
" " in canal at Shickshinny,	. .	(510.52)	510'
" " above Lock No. 7, at Beach Haven,	.		509'
" " " " No. 6, at Berwick,	. .	(499.80)	500'
" " " " No. 5, at Stonytown,	. . . .		491'
" " " " No. 4, at Bloomsburg,		(481.69)	482'
" " " " No. 3, at Rupert,	. . . .		476'
" " in canal at Catawissa,	. .	(465.75)	466'
" " above Lock No. 2, 2 miles above Danville,			465½'
" " " " No. 1, 1 mile above North'bd,			454'
" " below " No. 1, 1 mile above Northumberland,	.	(442.81)	448'
" " in canal at Northumberland,	. .	(441.99)	442'
" " in Shamokin Dam,	. . . .	(429.44)	429½'

West Branch Susquehanna Canal. The following elevations are taken from Mr. Ames' survey made in May, 1877: (see Report N, Table 115.)

Commencing at Williamsport.			*A. T.*
Surface of water in Williamsport dam,	. . . . .	(507.87)	508'
" " in canal at Williamsport,	. . . .	(518.90)	519'
" " above Lock No. 27, Montoursville,	. . .		518¾'
" " " " No. 26,	. . . .		512½'
" " " " No. 25, two miles below Montoursville,		(507.62)	508½'
" " " " No. 24,	. . . .		501½'
" " " " No. 23, Hall's,	. . . .		496½'
" " " " No. 22, Muncy,	. .	(489.93)	490'
" " " " No. 21,	. . . . . .	(484.42)	484½'
" " in Muncy Dam,	. . . .		469'
" " above Lock No. 18, Watsontown,	. . . .		467'
" " " " No. 17, Milton,	. . . . .		462'
" " " " No. 16, Lewisburg,	.	(449.62)	450½'
" " " " No. 14, Montandon,	. . . . .		455½'
" " " " No. 13, Northumberland,			449¾'
" " in Shamokin Dam,	. . . .	(429.44)	429½'
" " below Sunbury Lock,	. . . .		427½'
" " above Port Trevorton Lock,	. . . .		425'
" " " Hetzell's Lock.	. . . .		417½'
" " " Mahantango Lock,	. . . .	(419.97)	411'

The general relief of the central portion of the district is well shown by Barometric elevations taken along the Pike that runs from Berwick, in Columbia county, northward to Bernice in Sullivan, past Long Pond, at which the following list of levels begins and proceeds southward:

	Barometric A. T.
Along the Berwick pike.	
Long Pond,	2200′
Berwick Pike at Long Pond Hotel,	2250′
" " at by-road near Luzerne county line,	2190′
" " at summit of North Mountain,	2260′
" " at by-road to Dodson's Pond,	2220′
" " in front of Hacker's Hotel, foot of North Mountain,	1385′
" " at A. Fredley's (near last),	1325′
" " 200 rods south of last,	1225′
" " 559 " " "	1150′
" " 111 " " "	1125′
" " 232 " " "	1180′
" " 71 " " " (Fairmount Springs),	1180′
" " 237 " " "	1110′
" " 131 " " "	1235′
" " 118 " " "	1205′
" " 49 " " "	1150′
" " 163 " " "	975′
" " 167 " " "	990′
" " 61 " " "	985′
" " 231 " " " (Cambria P. O.),	1015′
" " 317 " " "	935′
" " 123 " " "	950′
" " 144 " " " (New Columbia),	1175′
" " 110 " " "	1125′
" " at cross roads near H. C. Kline, in Columbia county, one mile south of last,	755′
" " 383 rods south of last	725′
" " at Jonestown, ½ mile next south,	695′
Huntington creek at Jonestown,	680′
Berwick Pike at A. Parks, 100 rods south of last,	740′
" " at summit of Huntington Mountain, 506 rods from last	1500′
" " at Shickshinny creek in center of Wyoming synclinal,	1140′
" " at summit of Knob Mountain, in gap,	1230′
Crest of Knob Mountain, east and west from gap,	1500′
Berwick Pike at foot of Knob Mountain,	935′
" " on summit of ridge next south,	1050′
" " at M. E. Church one mile south of Brier creek,	1025′
" " at A. Fowler's, 400 rods south of last,	685′
" " in Foundryville,	645′
General level of Berwick,	575′
Susquehanna river at Berwick,	475′
Crest of Nescopeck Mountain, 3 miles south of last,	1600′
Catawissa Valley ½ mile south of Nescopeck Mountain,	950′

The Glaciated region.

The Northern Ice Sheet seems to have covered only about half of this district, viz: Wyoming, North Lackawanna, Luzerne, and a very narrow strip along the eastern border of Columbia county.

The great Terminal Moraine, as traced out by Prof. H. Carvill Lewis, enters this district from the south near Berwick, (at the eastern line of Columbia county) and extends northward to the foot of Knob mountain. Here it swings eastward up along the same for several miles into Luzerne county; crosses Knob and Huntington mountains; and then passes back into Columbia county down along the northern slope of Huntington mountain, into Huntingdon valley.

The only change that my observations make in this, is to modify slightly the curve of the *moraine* across Knob and Huntington mountains, by making it double; for I found vast heaps of moraine covering the valley of West Shickshinny creek (between Knob and Huntington mountains) to a great depth, and extending westward into Columbia county to within one half mile of where the Berwick pike crosses that valley. Hence, it is evident that Knob and Huntington mountains projected in two long sharp headlands eastward into the *mer de glace;* while an arm of the latter, ending in a narrow point, extended between the two headlands several miles west from their extremities.

From about one mile above the mouth of Huntington creek, the course of the *moraine* again strikes northward, keeping just east of Fishing creek; and thus it continues northward to the base of the North Mountain, bending over slightly westward, so that it leaves the district along the valley of Fishing creek.

The most western point at which *glacial scratches* were observed is just east from the east branch of Fishing creek, in Sugar Loaf township, where a very hard Catskill sandstone is polished off smooth, with *striæ* pointing almost due south, at an elevation of 975′ A. T.

The prevailing direction of the *Ice Striæ* is S. 30°-45° W. over Wyoming, Lackawanna, and Luzerne, as will be seen

from the following list of determinations in these several areas, given in subsequent pages of this report:

Striæ in Wyoming county.

Meshoppen township,	S. 30° W.
Washington, "	S. 28°, 30° and 32° W.
Tunkhannock "	S. 35°-40° W.
Lemon "	S. 35°-40° W.
Nicholson "	S. 35° W.
Eaton "	S. 35°-40° W.
Windham "	S. 38° W.
Monroe "	S. 45° W.
North Moreland "	S. 40° W.

Striæ in north Luzerne county.

Kingston township,	S. 35° W.
Franklin "	S. 32°-35° W.
Dallas "	S. 45° W.
Lake "	S. 50° W.
Union "	S. 65°-70° W.
Fairmont "	S. 70°-80° W.

The only *glaciated* surface seen by me in Columbia county is that mentioned in Sugar Loaf township, while not a single *Ice scratch* was observed in Montour or Northumberland counties.

North Lackawanna seems to have been completely covered with the Ice, and the *striæ* as seen in Abington and other townships point S. 35°-40° W.

It is not certain that the Ice covered all of Wyoming county; in fact it seems fully proven by the absence of all traces of glaciation that Miller's Mountain below Tunkhannock rose as an island above the surface of the Ice.

Also neither *striæ* nor *transported bowlders* were seen on the elevated (2000'-2200 A. T.) plateau along the western line of Wyoming county. It is possible however that both may exist in parts of it not examined by me.

All of the striated surfaces that I have seen in the district, occur below 1300' A. T., but this is largely accounted for by the fact that the *Catskill rocks*, (except where they are capped by *Pocono's beds*, and then they are found in the escarpments of mountains where *glacial scratches*

would seldom be made, and very rarely preserved), do not rise to a greater elevation than 1300′ A. T., and these beds cover practically all of the region that has been glaciated.

Whether or not the North Mountain region of Luzerne and Columbia counties has been glaciated, I am unable to say, since my examinations on it were limited, and although I found no evidence of Ice occupancy, it is possible that such does exist in other localities than those visited.

The Drift-covering left by the retreating Ice has a thickness of 40′-50′ in many portions of Wyoming, even on the summits of hills where some of its original thickness must have been lost by rain erosion. But it must have varied greatly, for some of the rocks most conspicuously striated are protected by only a thin coating of soil.

The valleys of the streams are now the main receptacles of the *original Drift*, since the slopes have largely shed the deposits originally left on them.

The materials of the Drift are quite various, and, in all cases of unmodified Drift that have come under my observation within the district, consist entirely of *local rocks ; i. e.* no rocks have been found in the undisturbed Drift of this district from any beds older than those cropping out somewhere within the same. True, small bowlders of *granite*, *gneiss*, *labradorite*, and other *crystalline rocks*, are often seen in the great gravel beds along the Susquehanna valley ; but according to my view all of these have been transported into this district by running water, and not by the *Ice*.

This seems proven by the following facts: (1.) They are found only along the immediate valley of the Susquehanna river, or regions reached by the waters of that stream during the *Flooded river epoch ;* not a single one having been seen on any of the *high* hills which border that river, or in any of the Drift heaps remote from it; (2.) *Every crystalline bowlder* seen was small, none having been observed of more than 1′ in diameter, and by far the larger number are only 1″-3″, while all are rounded and polished by long attrition in water ; (3.) This same class of bowlders continues on in the gravel deposits which border the North

Susquehanna river to its mouth, many miles beyond the limits of the *Ice sheet*, and hence must have been transported by water to this portion of the district.

From all these considerations, it seems conclusive that the small *crystalline bowlders* found in great numbers in all the gravel deposits which now border the North Susquehanna valley do not belong to the *Drift* of this region, but were transported into it from that rehandling of more northern *Drift* deposits during the "*Flooded river epoch*" which took place during the retreat of the *Ice.*

From my own observations in Susquehanna county in 1880, and in Bradford in 1882, it seems probable that the *crystalline rocks* were transported by *Glacial movement* as far south as the middle line of these counties; but possibly this is a mistake, since all of the *crystalline bowlders* even there are small and rounded, so that they in their turn may have been transported by water from localities still further north.

For a fuller account of the *Ice Epoch* in this district and other regions of Pennsylvania, the reader is referred to the Report of Prof. H. C. Lewis, on the Terminal Moraine, Report Z, 1883.

Flooded river transportation.

Great heaps of rounded and polished bowlders are found over a large portion of the district west from the line which Prof. Lewis has fixed as the limit of *Glaciation.* They occur alike in valleys, and on the summits of hills which do not exceed an altitude of 950′ A.T., though they are much more abundant over the low country which stretches from Fishing creek westward to the West Susquehanna along the line of the *Milton* and *Watsontown anticlines.*

Not all have been water-worn, however, since many angular ones occur, and in one or two instances *scratched bowlders* were seen among them like those always found in *true Drift.*

Occasionally, indeed, these transported bowlders are all of them angular, as seen in the bowlders of *Clinton rocks* which almost cover the Hamilton and Chemung beds, south

from Montour ridge, in Point township of Northumberland county. At this locality bowlders of *Clinton Iron Sandstone* have been transported across a valley of No. VI-VIII and landed on the summit of the Chemung ridge more than 250′ above the bottom of the intervening valley.*

The majority of these transported bowlders belong to the *Pocono sandstones* (*No. X;*) though all the rocks of the district are represented among them, from the conglomerates of *No. XII* down to the sandstones of the *Clinton* (*No. V.*)

The highest point at which these bowlders were seen by me is 950′ A. T., and this occurs two miles south from Catawissa, where they cover the summit of a ridge between Roaring creek and the Susquehanna river.

On account of the general distribution of these bowlders it at first seemed to me probable that the *Glacial Ice* had extended in several tongues much further westward than Prof. Lewis or myself had supposed, and had transported this material which very often exactly resembles *genuine Drift*. But when further examinations failed to find a single case of *Ice striation* on any of the rocks of the region in localities where such *striæ* would almost certainly have been preserved if they ever had been made, it became apparent that some other explanation for their transportation must be devised.

In view of all the facts in hand it seems to me probable that these bowlders were transported by floating ice and other means in a great lake-like river which flowed westward from the *Terminal moraine* (at the eastern line of Columbia county) during a *Flooded river epoch*, when hills now rising 800′-900′ A. T., were submerged.

That this sheet of water was an actual river seems proven by the great bowlder deposit which it made at its junction with the West Susquehanna, at the northern line of Northumberland county; for, there, a great bluff of transported

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*The Formation Numbers of the First Geological Survey are often used in this report, for convenience sake. As in this instance "a Valley of VI-VIII" means a valley eroded out of the upturned edges of Lower Helderburg (No. VI) and of Marcellus, Hamilton and Genesee rocks (the lower divisions of No. VIII.)

bowlders 175' high extends along the east bank of the river nearly two miles.

The upper limit of these bowlders along the northern line of Northumberland county is about 800' A. T. Not a single one could be found above that elevation at several points where careful search was made.

The Chemung rocks rise in a rather steep slope to an elevation of 1100'-1200' A. T. all along the northern portion of Northumberland county; and the transported bowlders of Pocono sandstone and other local rocks, most of them water-worn, are found along the base of this Chemung slope up to 800' A.T. Here they suddenly disappear; but to the south they cover all the low hills and valleys of *Hamilton*, *Lower Helderburg*, and *Salina rocks*, until we come to Limestone Ridge, a distance of ten miles. They are most abundant, however, over the northern half of these lowlands. None of the hills in this Hamilton-Salina area rise higher than 750' A. T. As already stated, the bowlders extend eastward along the *Hamilton shale* through Northumberland, Montour, and Columbia counties until they connect with the great *Terminal moraine* near the eastern line of the latter county.

It is possible that the rapid melting away of the *Glacial Ice* may have supplied water in sufficient quantity to submerge all the region in question, without any great subsidence of the land beneath sea level; but in that case the river which carried off this water must have had a depth of more than 200', and a breadth of 2-10 miles over much of the region along the Milton and Watsontown axes.

River gravels and terraces.

Whatever were the means by which such vast quantities of débris have been spread so widely over the surfaces of moderate elevation in localities lying outside of the *region of glaciation*, there is still another class of deposits that were certainly transported by the "flooded rivers" which carried off the water from the melting and retreating *Glacial Ice*.

These deposits are now found in great heaps of commin-

gled sand, gravel, and bowlders of almost every size from 4 inches up to 4 and 5 feet, at many points along the north and west Susquehanna rivers, but are especially prominent at the junction of these rivers with their principal tributaries.

At the mouth of Tunkhannock creek, in Wyoming county, a large *gravel deposit* rises to 125′ above the Susquehanna river, and then spreads out into a wide plain; but when followed up the valley of Tunkhannock creek, a sharp low ridge of gravel and bowlders is seen for more than a mile, near the center of the valley, exactly resembling the "kames" of Upham and other authors, but evidently formed in this case by the checking of the Tunkhannock creek current upon meeting that from the north Susquehanna.

The tusks and teeth of the mastodon have been found in these deposits at Tunkhannock.

This bowlder deposit lines the Tunkhannock valley in a narrow *terrace*, slowly declining in altitude above the level of the stream until the bed of the latter has risen to about the same elevation as the top of the deposit (680′ A. T.) at Tunkhannock, when it disappears altogether.

Terraces.—Very frequently these deposits are found in *terraces* rising one above the other, with steep escarpments between.

In the vicinity of South Easton, Wyoming county, the succession of these terraces along the north Susquehanna river is as follows:

First terrace, a narrow shelf composed entirely of river mud and silt, and evidently constituting the present flood-plain of the Susquehanna; height at top above low water in Susquehanna, 35′.

The second terrace rises with a very steep escarpment from the top of the first to an elevation of 100′ above low water, when it spreads out in a broad plain covered with small rounded bowlders, among which are great numbers of *crystalline origin*. The escarpment of this terrace is also composed largely of small rounded bowlders, very few angular ones being visible.

The third terrace slopes up gradually to an elevation of 150′ above the river, where it spreads out into an undulating plain. It too contains many bowlders, but very few of *crystalline origin.*

The fourth and highest *terrace* has but a very small extent, being often only a narrow shelf along the hills at an elevation of 200′ above low water, or 770′ A. T. Its top is marked in some places, (as near Mr. Moneypenny's, below South Easton,) by a deposit of nearly white silicious clay, which seems to mark the uppermost limit of the north Susquehanna during the *flooded river epoch.*

Below that locality, and about one mile above Falls station, on the east bank of the Susquehanna river, two beautiful terraces occur, the top of the first coming at 30′ above river level, from the inner margin of which an almost vertical escarpment of *bowlder trash* rises to an elevation of 125′ above the river, or 690′ A. T., where it spreads out into a wide and nearly level plain.

The first terrace is composed of fine sediment and is the present river's flood plain. *Bowlders of gneiss and granite* are quite numerous in the escarpment and top of the second terrace, but the largest one seen by me was only 4″ in diameter, while all are rounded and polished.

At Falls P. O. a bowlder bed rises to 185′ above low water in the Susquehanna river, or to 745′ A. T.

The great gravel deposits which spread across the Wyoming valley north from the Susquehanna river in Luzerne county, have largely resulted from the rehandling of drift material during the *Flooded river epoch.*

The Wyoming monument stands on the summit of one of these *gravel plains* about 70′ above low water in the river. On the hill slopes, however, the gravel and bowlder beds extend up to 175′ or more above the Susquehanna.

The Lackawanna river has doubtless brought into the Wyoming valley a large share of the gravel and bowlder trash which is now found in it.

Passing down the North Susquehannna river from Kingston the bowlder beds disappear, and no more deposits of any

consequence are seen until the mouth of Wapwallopen creek is reached, 25 miles southward.

Just below the mouth of the Wapwallopen is a vast deposit of bowlder trash, its escarpment rising very abuptly to an elevation of 175′ above the Susquehanna, and stretching in a broad plain along the south bank for nearly three miles.

Gravel deposits occur here also on the north side of the Susquehanna, and the following succession of terraces was observed at Beach Haven:

Top of 1st terrace above river,	30′	A. T.	510′
" " 2d " " "	50′	"	530′
" " 3d " " "	170′	"	650′

The river has an elevation of 480′ A. T. and the top of the third terrace therefore comes at 650′ A. T., where it spreads out into a wide and nearly level plain, above which the bowlder deposits do not exist.

The great bowlder terrace at Berwick rises almost vertically from the bed of the Susquehanna river to 100′ above it, or 575′ A. T., and then makes a gently rising plain back northward. Briar creek debouches at Berwick, and seems to have brought in much of this bowlder trash.

At Bloomsburg, Fishing creek valley unites with that of the North Susquehanna, and a wide stretch of plain is covered by bowlder trash about their junction; the following succession of terraces being shown:

Top of 1st terrace above Susquehanna river,	20′	A. T.	470′
" 2d " " " "	40′	"	490′
" 3d " " " "	70′	"	520′

On the Fishing Creek side, the second terrace is absent, and there is an abrupt descent of 50′ from the top of the third to the top of the first.

The third terrace is covered with a deposit of clean reddish grey sand, 15′–20′ deep, below which comes gravel and rounded bowlders. The main portion of Bloomsburg is built on this third terrace, while the station of the D. L. & W. R. R. is on the second terrace.

No terraces higher than the third given above were seen at Bloomsburg; but two miles below, very thick gravel beds

are seen extending up to an elevation of 175′ above the Susquehanna or 625′ A. T.

This same gravel deposit is frequently seen in the old valley which leads from Rupert westward to Danville along the line of the Catawissa & Williamsport (Reading) railroad, and its top is generally found at about 625′-630′ A. T. Many small bowlders of *crystalline rocks* occur in it.

No gravel deposits of any consequence occur between Rupert and Danville, along the North Susquehanna river; but below Danville they come in again, and extend from Chulasky to Northumberland, making a wide level valley along the north bank about 50′ above the river, or 485′ A. T.

Many large bowlders of *Pottsville conglomerate* occur on this terrace.

In the vicinity of Northumberland the succession of terraces is as follows:

		A. T.
Top of 1st terrace above Susquehanna river	25′	455′
" 2d " " " "	55′	485′
" 3d " " " "	80′	510′
" 4th " " " "	175′	605′

The 4th or uppermost terrace is scarcely marked, but was indicated by a bowlder of *gneiss*, one foot in diameter which was observed at 175′ above river level.

Along the main Susquehanna river below Northumberland, only one large bowlder bed occurs within the district, and that is on the east bank of the river opposite the water tank, below Selinsgrove junction.

Here a great pile of rounded bowlders extends to 215′ above the present bed of the Susquehanna, ending abruptly on a gentle slope at this altitude, or 625′ A. T., above which nothing but angular country rock is to be seen.

The Susquehanna valley is nearly two miles wide at the 215′ line, and if the *Flooded river* that transported the bowlder trash, had its bed on the present floor of the Susquehanna, the volume of water passing down must certainly have been very great.

Buried Valley at Wilkes-Barre.

For an account of the manner in which Lakes Harvey,

Wynola and Marcy were formed by the damming up of ancient valleys with Drift during the Ice Age, the reader is referred to the detailed or township geology of the report.

There is one buried valley in the district which possesses a peculiar interest; namely that of the old Susquehanna river between Pittston and Kingston.

The Wyoming valley has been explored with the drill by the various mining companies, and it was from such records that the facts now to be given were obtained. For most of them I am indebted to Mr. R. D. Lacoe of Pittston, who has done so much through his magnificent collections to advance our knowledge of the *Coal Flora* of Pennsylvania and other States.

This ancient valley did not follow the present channel of the Susquehanna, but kept north of it, not far from the low region which extends from opposite the mouth of the Lackawanna river rudely parallel to and several rods north from the D. L. & W. R. R. through Exeter township.

The D. L. & W. R. R. seems to run near the center of the old buried valley entirely across Kingston township.

The buried valley passes under the town of Kingston and re-enters the present river channel at the short bend just west from Kingston.

Near the western end of the railroad bridge across the Susquehanna river at West Pittston, *bed rock* was struck in a shaft at only 69′ below the surface, or not more than 30′ below the level of the present river, thus showing that the old channel lies further north.

The Schooley shaft, recently put down about half way between West Pittston station and Wyoming, 100 yards north from the D. L. & W. R. R., shows—

		A. T.
1. Clay,	6′	560′
2. Quicksand and gravel,	14′	
3. Sandstone massive. (in place?)	14′	
4. Quicksand and bowlders,	26′	
5. Loose rock and clay,	26′	
6. Quicksand and gravel,	4′	
7. Bed rock, a sandstone whose top shows the scouring action of running water at a depth of 90′.		470′

The shaft begins at 560′ A. T. and the bottom of genuine bed rock comes 90′ lower, or 470′ A.T., (60′ below river level.)

This seems to have been on the very brink (southern) of the old channel; for No. 3 was genuine bed rock, and must have formed an overhanging cliff projecting over the southern edge of the old water-way; since quicksand and small rounded bowlders, as well as other rock not bedded, occurred below it.

I was shown the rock which came up from a depth of 90′, and its top was plainly scoured and smoothed by the action of running water.

About 200 rods *north from the Schooley shaft* and near Mr. W. S. Shoemaker's, a hole was bored to a depth of 63′ 2″ before bed rock was struck. Since it begins at about the same level as the shaft, this would show that the old channel lies between the two points.

At the edge of Kingston township, in the corner of Wyoming Fair Ground, a hole was bored to a depth of 130′ 10″ before striking bed rock. It begins at about 590′ A. T., and therefore descends to about 70′ below the present level of the Susquehanna, 200 rods south of it, *i. e.* 530′–70′= 460′ A. T.

At the side of the lane, about 100 rods west from Wyoming station, bed rock was found at 103½′, or 465′ A. T.

On the land of Mr. G. Shoemaker, near Forty Fort, and about 40 rods south from the D. L. & W. R. R., a hole was bored in which no bed rock was found until the drill passed 212′ below the surface, or to 340′ A. T.

Top of hole 552′ A. T.

Bottom of hole (525′–340′) 185′ below present level of river near Forty Fort, just opposite the boring.

In this hole no gravel or bowlders were encountered except near the surface, but the material was fine mud and quicksand.

Nearly two miles west from Forty Fort, and about 100 rods east from the mouth of Toby's creek, on what is known as the Kingston flats, in the eastern edge of Plymouth township, another hole was sunk to a depth of 210′.

Top of hole 550′ A. T.

Bottom of hole 340′ A. T.; or 180′ below river at Kingston.

In this hole like the one near Forty Fort, no gravel nor bowlders were found, but only quicksand and fine mud.

There is also a *buried valley* of considerable depth extending north-eastward from the Susquehanna at Pittston along the Lackawanna river; since a hole bored near it, about two miles above Pittston, passed through loose deposits for 80′ below river level before reaching solid rock.

The fact of especial interest in connection with this Buried Valley, is that it seems to end near Berwick.

At Beach Haven, 3 miles above Berwick (where Prof. Lewis locates the western limit of glaciation), *Hamilton shales* are seen extending almost entirely across the present channel of the North Susquehanna; but it is possible that here an old channel may exist under the broad plain of bowlder trash which stretches back from the south bank.

At Berwick and Mifflinville, the Hamilton shales also extend nearly across the present channel; and at Mifflinville there would seem to be little chance for a concealed ancient channel.

Below Bloomsburg, however, the Hamilton and Chemung rocks can be followed nearly across the valley just above Rupert, where the rocky cliffs rising on either side preclude the possibility of a buried channel.

The river at Bloomsburg is 110′ higher than the bottom of the old buried channel near Kingston, (340′ A. T.); *i. e.* is 450′ A. T.

But lest there should be a possibility of a concealed channel deeper than the present one at Bloomsburg, we shall go down to the main Susquehanna below Northumberland, and here we find a ledge of *Hamilton sandstone* extending entirely across the present channel at Shomokin Falls, near Sunbury, with an elevation 90′ higher than the old channel near Kingston, (430′ A. T.)

There is a small space just west from Shamokin Falls, however, where an old channel might possibly exist; but below this, between Selinsgrove Junction and Mahantango creek, there are several localities where the massive *Selinsgrove sandstone* of the Hamilton series can be seen extend-

ing completely across the Susquehanna channel and valley and rising in ridges on either bank; so that no buried channel can possibly exist there; the elevation of the Susquehanna where it leaves this district being 385′ *i. e.* 45′ higher than the old channel of the North Susquehanna at Kingston, (340′ A. T.)

The distance between Kingston and Selinsgrove Junction is 70 miles, and the present waterway descends (520′-410′) 110′ between the two points, but yet the depth to which the old buried channel extends near Kingston (340′ A. T.), is 70′ lower than the rock-floored valley of the Susquehanna at Selinsgrove.

[I omit from this report the conjectures to which the facts above mentioned give rise, because they have neither scientific nor practical value. Until we have obtained more facts it is useless to indulge in vague speculations concerning causes.—J. P. L.]

CHAPTER II.

Geological structure of the region.

As already stated, the rocks of Wyoming county are practically horizontal, since no strong anticlinals nor synclinals cross that county; but as we pass southward through Luzerne, Columbia, and Northumberland, the rocks are thrown into arches so high as to expose the *Medina sandstone No. IV*, the base of the Upper Silurian system, and into troughs deep enough to preserve nearly the highest coal measures.

In passing across the district from north to south the following anticlinals and synclinals succeed each other:

Wilmot anticlinal.

This axis goes through the extreme north-west corner of Wyoming, passing across the Susquehanna river near where the latter enters the county. It brings the top of the *Che-*

mung beds above river level from the mouth of Tuscarora creek, near Skinner's Eddy, north-westward into Bradford county; but the dips are gentle, nowhere exceeding 5°–6° on either side of the arch, and the *Chemung beds* are not lifted higher than the bluffs which border the Susquehanna river.

The direction of the axis could not be accurately obtained in Wyoming, owing to the general horizontality of the beds, but cannot vary much from S. 65° W.

Bernice synclinal.

Mr. Sherwood has given the above name to the downward fold of the rocks which holds the *coals* of Sullivan county in the vicinity of Bernice; keeping on eastward into Wyoming county just north from Bella Sylvia; passing just north from Forkston; and continuing as a gentle depression in the rocks across the county, about eight miles distant from the *Wilmot anticlinal.*

The Pottsville conglomerate is caught in the center of this depression over a narrow belt in North Branch township at the western line of the county; but elsewhere only *Pocono* and *Catskill beds* are found in this trough; and east from the Susquehanna river only the latter occur; for the trough turns slowly upward toward the north-east; and then erosion has removed all of the *Pocono* and much of the underlying Catskill from all the region occupied by this basin east from the Susquehanna river.

Passing south-eastward from the *Bernice syncline* the rocks of Wyoming county are so nearly horizontal that no well-marked axes could be made out until we get beyond its south-eastern corner, on the Susquehanna river; though doubtless minor waves do traverse the rocks. *A trough* seems to cross the Susquehanna river in the vicinity of Tunkhannock, since the Miller mountain near there rises high enough to catch the basal beds of the *Catskill Pocono,* which could hardly be possible otherwise. This would also account for the course of Tunkhannock creek, which flows down the trough from the north-east, and also that of Bowman's creek, which meets the Tunkhannock from the south-west.

White Deer (Watsontown) anticlinal; Milton anticlinal; and intermediate folds.

These flexures are the eastwardly declining ends of the six anticlinals of the Buffalo Mountains of Western Union and Snyder counties,—the mountains which split up Kisicoquilis Valley, and the so called "Seven Mountains" north of that valley. The old State map of 1842 (1858) shows this beautiful series of anticlinal spurs. The whole region and its structure will be published in Mr. Billin's Report S. The Buffalo Mountain axes appear in the river section between Watsontown and Milton.

A great fold comes from across the West Susquehanna river in the vicinity of Watsontown to which I give this name.

Just west from the river, in Union county, this axis brings up the massive sandstones of No. IV in the White Deer mountains, but only the top of the *Clinton beds* are elevated above water level at Watsontown.

Followed eastward from the West Susquehanna river the *Watsontown axis* passes through the southern portion of Delaware and Lewis townships of Northumberland county, where it spreads the *Salina beds* over a considerable area.

Four miles south of Watsontown, at the town of Milton, another of the great Buffalo mountain anticlinals of Union and Clinton counties crosses the river and passes on eastward through Washingtonville, in Derry township of Montour county, just west of which it elevates the *Oriskany sandstone* and *Lower Helderberg limestone* into the long, high Limestone Ridge which begins at Chillisquaque creek, in Montour county, and extends westward through Northumberland to the West Susquehanna river below Milton.

The line of this axis runs just north of the crest of Limestone Ridge, and it brings up the *Salina beds* along its course through Northumberland county.

Entering Montour county in Limestone township, it traverses the southern half of the latter; declining eastward,

so that at the eastern border of Limestone township the *Lower Helderberg beds* arch over its crest.

Through Derry township, it passes north of the Washingtonville Fair grounds, one mile and a half east from which the *Hamilton beds* cover up the *Lower Helderberg* and extend in a wide valley eastward into Columbia county through the central portion of Madison and Greenwood townships, entering the latter across Little Fishing creek at the south-eastern corner of Pine township, in the vicinity of Millville. It crosses Big Fishing creek just south of the village of Still-water and enters Luzerne county near the north-eastern corner of Fishingcreek township. Followed eastward through Luzerne county this axis passes across Huntingdon, Union, Lehman, Dallas, and Exeter townships reaching the North Susquehanna, near the northern line of the latter.

The axis continues to die away rather rapidly eastward, the *Chemung beds* covering up the *Hamilton* east from Big Fishing, while the former are in turn arched over by the *Chemung-Catskill rocks* eastward from the center of North Luzerne.

Through Lackawanna county this axis flattens still further, so that the *Catskill beds* override its crest across the most of that county.

Waverly and Tompkinsville seem to be near the center of its path through the latter county.

The dip of the rocks on the south side of this anticlinal is everywhere steeper than on the north-west, since it seldom exceeds 20° on the north, but is often 45°–50° on the south. This great difference does not appear near the crest of the arch, however, but begins to be noticed at some distance south-east from it.

All through Luzerne county the descent of dip north from the crest is quite gentle, not exceeding 8°–10° anywhere, and this gradually flattens eastward, so that when Lackawanna county is entered, the northward dip is almost nothing.

Between this and the Watsontown anticlinal are four minor flexures which bring up the *Bloomsburg red shale.*

The Lackawanna Synclinal.

This name has been given to that great downward fold of the rocks which, entering the district at the extreme north-east corner of Lackawanna county as a narrow, shallow trough, gradually deepens and broadens toward the south-west, until in the vicinity of Wilkes-Barre it retains the entire *Coal Measure series*, and possibly a small cap of the *Permo-carboniferous.*

From the locality of maximum development of the Lackawanna basin (Wilkes-Barre and Plymouth) it then begins to shallow and narrow up westward, so that at Shickshinny, 15 miles south-west, the *Coal Measures* remain only in a narrow, triangular area west of the river.

Westward from Shickshinny the axis of the trough runs along the center of the old drift-filled valley of West Shickshinny creek, with a mountain of *Pocono sandstone* both north and south; but the Pocono trough gradually narrows and shallows westward until its two rims come together at Orangeville, in Columbia county, and then the *Pocono beds* vanish in the air, leaving the *Catskill rocks* to occupy the trough westward through the center of Mount Pleasant township, and along the northern border of Hemlock; but they in turn tail out at the eastern edge of Montour county, in West Hemlock township.

The Catskill-Chemung beds continue on to the east branch of Mahoning creek, in Valley township, when they, too, disappear, and the hard *Chemung rocks* make a ridge westward to near the center of Liberty township; the *Hamilton beds* then occupy the trough westward through Pottsgrove, in Northumberland county, to the West Susquehanna river, about one mile above Montandon.

The westward ascent of this synclinal axis may be appreciated when it is stated that a shaft in the vicinity of Wilkes-Barre would have to be sunk 10,000′–12,000′ to reach the (Lower Hamilton) rocks exposed at Montandon.

The Berwick (Montour) Anticlinal.

The next fold in the rocks comes about four miles south from the last, and is much the greatest one in the district.

It passes under the town of Berwick, from which I have named it in this report.

The Berwick axis crosses the river, about half way between Big and Little Wapwallopen creeks, where it brings up a broad band of *Hamilton beds*, in which the Susquehanna turns west and flows along the strike of these rocks, just south from the line of the axis, to Berwick.

The Lower Helderberg limestone is elevated to the surface a short distance west from Berwick, and it very probably first emerges near the eastern line of the borough, but has been eroded and its outcrop deeply buried by the terrace deposits which cover up all the rocks to a great depth in that vicinity.

The Salina beds are brought up, one mile west from Berwick, and then a low ridge begins along the crest of the arch, which gradually increases in elevation westward through the southern half of Center and Scott townships, becoming still higher across Bloomsburg township where the *Clinton rocks* come to the surface.

The axis crosses Fishing creek one half mile north from the town of Bloomsburg, and about 300 yards north from the Bloomsburg Iron Company's Furnace.

Fishing and Hemlock creeks trench squarely crosses the axis, in the vicinity of Bloomsburg, through large gaps in Montour's ridge; but westward from Hemlock creek the very hard *Clinton Iron sandstones* and underlying silicious shales arching over the crest of the fold carry Montour's ridge up to about 1100′ A. T.

The course of the anticlinal west from Hemlock creek coincides exactly with the northern line of Montour township, and it enters Montour county along the northern boundary of Cooper, making a long, straight ridge westward near the north line of Mahoning township, and passing just north from Danville where Mahoning creek cuts a deep gorge through the ridge. West from this, however, it rises again to a great elevation, 1000′–1200′ A. T., and the crest of the arch separates Montour from Northumberland county, following closely the northern line of Point township westward through Northumberland to the West Sus-

quehanna, which it reaches at the mouth of Chillisquaque creek, where the river has made a wide breach through the arch.

This conspicuous elevation along the crest of the Berwick axis is known as Montour Ridge westward from Bloomsburg, but as it is the same fold which begins to make a *ridge* near Berwick, I have in this report given the name *Montour* to this uplift throughout its whole extent within the district.

Montour ridge is rendered all the more prominent from the fact that it is bordered on each side by the soft beds of the *Salina*, and *Hamilton* which weathering away into broad, low valleys along both the north and south slopes of the ridge seem to increase the height of the latter by contrast.

The greatest hoist in this arch appears to be at a point just west from Danville, for here, where the North Susquehanna river cuts northward, the top of *Medina sandstone* is revealed on the south slope of the anticlinal, the only locality in the district where any of the rocks of No. IV are brought to the surface.

The *Berwick anticlinal* is virtually a prolongation eastward of that of Jack's mountain which brings up the *Siluro-Cambrian limestones* of Kishicoquilis Valley in Mifflin and Huntingdon counties.

The Berwick arch seems to be very nearly symmetrical; though in the vicinity of Hemlock creek, and westward toward Danville there is, according to Rogers, a slight warping or flattening of the rocks for a short distance on its northern slope. The dip is about the same (40°–45°) both north and south from its crest; though in the *Chemung* and *Catskill beds*, on the north side, dips of 50°–60° were observed.

This axis is of great economical importance to the district, since it brings to the surface two belts of *Lower Helderberg* limestone, almost entirely across the district, and also those valuable *iron-ore deposits* of the *Clinton* which have rendered Bloomsburg and Danville famous for their iron industries.

The Northumberland synclinal.

By the above name I have designated a great trough, about four miles and a half south of the *Berwick anticlinal.*

It is one of the most remarkable basins which traverse Pennsylvania, extending, as it does, in a gentle curve from Bedford county, in the south, through Huntingdon, Juniata, Snyder, Northumberland, Columbia, and Luzerne counties nearly to the Lehigh river, a total length of about 150 miles. The Juniata river flows along it from Newton Hamilton to Lewistown Middleburg is on its southern side and New Berlin on its northern. Through most of its course in middle Pennsylvania it is very regular as to width and depth, but much complicated by subordinate folds. As it approaches the Susquehanna from the west it begins to widen and deepen gradually. Crossing the river at the forks (at Northumberland) it not only deepens, but becomes complicated going east, and widens (in Columbia county) into a group of basis separated by anticlinals.

The two deepest of these basins (which taken together may be considered as representing the axis or bottom of the great trough) hold the two projecting spurs of the Catawissa mountain. The other spurs of the mountain further south (on the Roaring creek and Beaver township line) represent other subordinate basins on the southern side of the great trough. In the Catawissa Valley the great trough is made up of numerous subordinate basins in one of which stands McCauley's mountain (with its fragment of coal measures), and in others lie the anthracite basins of Black Creek, Hazleton, &c.

From Northumberland and Sunbury eastward the general center line of the trough may be said to run near Kleingrove P. O. and Rushtown, and to cross Little Roaring creek near W. D. Mutchler's. Thence it proceeds to the end of the Catawissa mountain 1¼ miles south of Catawissa.

Shade Mountain (Selinsgrove) anticlinal.

A very strong anticlinal arch crosses the Susquehanna river two miles above Selinsgrove, one hundred and fifty yards south from the 135th mile-post of the Northern Central

R. R. and there brings up the top of the *Salina beds*, and elevates the *Lower Helderberg limestones* into a broad arch, much steeper on its northern slope (40°) than on its southern (20°.)

This fold dies rapidly down east from the river, and the *Oriskany sandstone* overrides its crest, to be in its turn covered up by the *Hamilton beds* after crossing Little Shamokin creek.

Traced eastward the main arch enters Shamokin township, and keeps about one mile south from Shamokin creek through the eastern half of that township, but crosses that stream about half way between Reed's and Paxinos stations, and passing under the town of Elysburg reaches Roaring creek just east from J. Richard's, where the *Genesee beds* are the lowest rocks brought above water level. These last are crowned with *Chemung* just east from Roaring creek, in Columbia county, while the latter are in turn covered by the *Catskill beds*, and they by the *Pocono*, before the axis crosses the eastern line of Columbia in the southern part of Roaring creek township.

The Selinsgrove anticlinal is not simple, but seems to have one or two minor folds on its northern slope which result in crumpling the *Hamilton rocks* and spreading them over a much wider valley along Shamokin creek than they would otherwise occupy. Two of these crumples are seen in the Hamilton beds about one mile and a half below Sunbury, the southern one being the largest. They were not observed by me at Roaring Creek.

There is also one small subordinate fold on the south side of the Selinsgrove anticlinal, its crest crossing the Susquehanna river just below Selinsgrove Junction, where the Marcellus beds are seen dipping northward; but this fold also I could not detect at Roaring creek.

The Shamokin synclinal.

After going southward from the last-mentioned minor fold, the rocks begin to steepen their dips quite rapidly, the *Chemung*, *Catskill*, *Pocono*, *Mauch Chunk*, and *Pottsville* formations, coming down one after the other, dipping

45°-50°, and finally the *Coal Measures* of the great Shamokin Anthracite Coal Basin.

The air line distance from the crest of the main Selinsgrove arch to the center of this trough is about 5 miles. Measured along the Susquehanna river (diagonally) the distance is about 6½.

The center of this basin crosses the Susquehanna about two miles north from Trevorton Junction, or Herndon. The basal members of the *Pocono beds* make the summit of the mountain which is formed by the united rims of that formation, and ends abruptly at the river.

Tuscarora Mtn. (*Georgetown*) *anticlinal.*

This important axis has a double crest, there being a sharp narrow synclinal fold running along the center of the main arch from Georgetown eastward to the western line of Jordan township, where it flattens out.

The Lower Helderberg limestone is brought up by each sub-arch through Lower Mahanoy township, and a narrow belt of *Hamilton beds* occupies the sharp little trough between them. Eastward from this, through Jordan township, only the northern sub-arch brings the *L. H. limestone* to the surface, the southern sub-arch dying down so that the *Hamilton beds* cover up the limestone.

On the north side of this double anticlinal the rocks dip at an angle of 40°-45°, while on the south side they go down at the rate of 70°-80°.

A subordinate fold of considerable extent crosses the measures at the 119th mile-post of the N. C. R. R. about two miles and a half below Georgetown, but it appears to flatten out eastward, as I saw nothing of it at the eastern line of Lower Agusta township.

CHAPTER III.

The Sub-carboniferous rocks.

The work in this district was confined entirely to the beds which *underlie* the *Coal Measures proper.* The Anthracite Survey in charge of Mr. Ashburner will report on the anthracite coal fields with great minuteness; hence the only portion of the Carboniferous system treated in this report, except incidentally, will be the *Mauch Chunk red shale No. XI*, and the *Pocono sandstone No. X.*

The base of the *Pottsville conglomerate No. XII* is everywhere a very massive, coarse, grayish white pebble rock; usually a mere mass of quartz pebbles of the common ovoid shape, varying in size from a pea to a hen's egg, all cemented into a matrix of coarse gray sand, and frequently containing vast quantities of imbedded plant remains, principally stems of *Sigillaria* and *Lepidodendron*, with many Carboniferous *fruits.*

A small bed of coal or highly *bituminous slate* often immediately underlies this massive conglomerate.

The following section taken in the gap of the North Susquehanna at Campbell's Ledge, near Coxton, in Lackawanna county, will show the stratigraphical relations of the coal in question, and also the character of the *Sub-carboniferous* (*Mauch Chunk* and *Pocono*) *rocks* at that locality:

Susquehanna Gap Section (Fig. 1, page 38).

Campbell's Ledge:

1.	**Massive, very pebbly, basal member of _Pottsville conglomerate_, ... visible**	**57′**
2.	**_Bituminous slate_, fossiliferous (plants and insects), . . .**	**5′**
3.	**Sandstone, gray, very hard, ...**	**3′**
4.	**_Mauch Chunk shale, No. XI._—Flaggy sandstones, and greenish sandy shales in which not a trace of _red_ could be found, ...**	**150′**

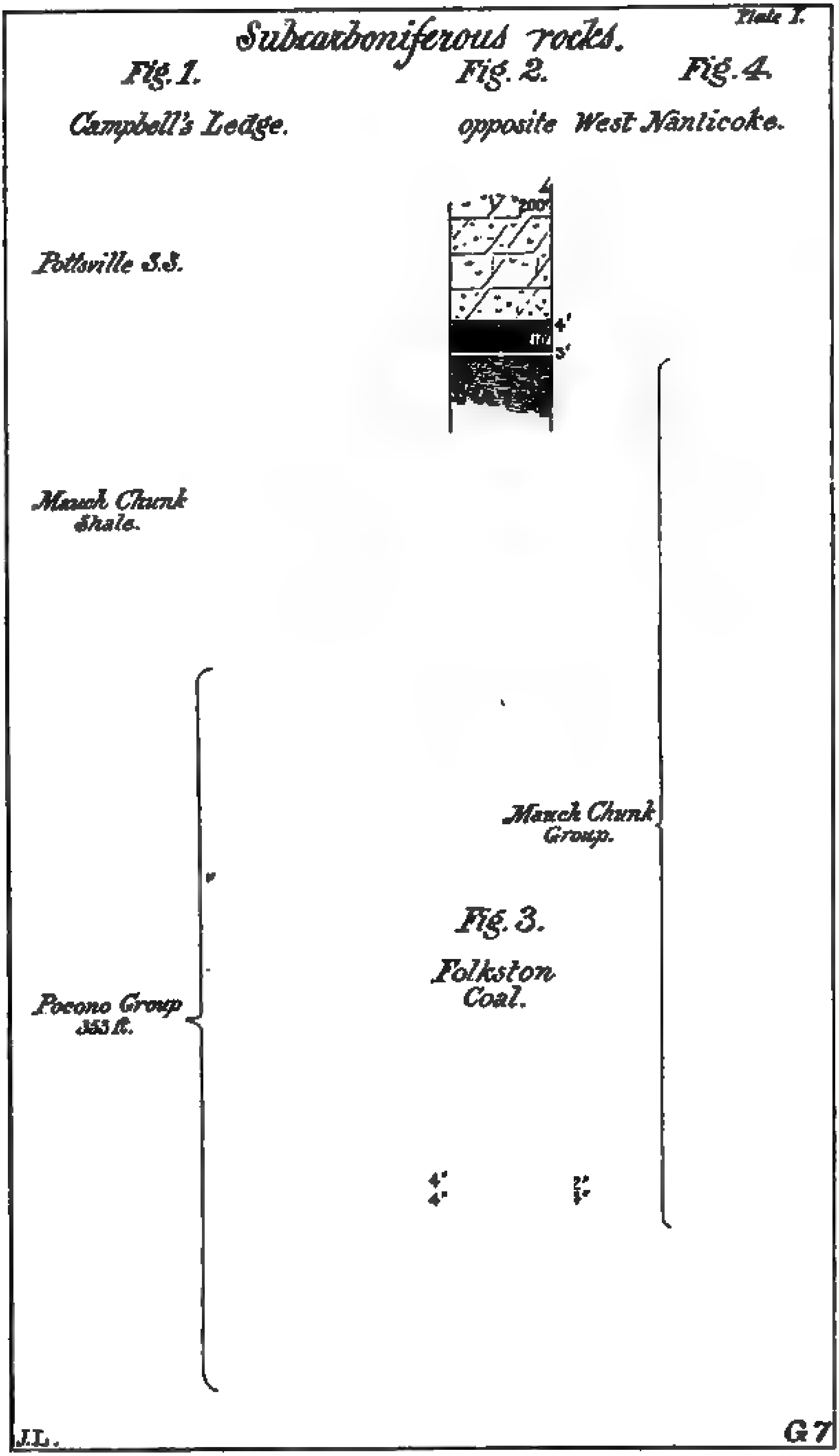


Plate I.
Subcarboniferous rocks.
Fig. 1.
Fig. 2.
Fig. 4.
Campbell's Ledge.
opposite West Nanticoke.
Pottsville S.S.
200'
4'
3'
Mauch Chunk
Shale.
Mauch Chunk
Group.
Fig. 3.
Folkston
Coal.
Pocono Group
353 ft.
J.L.
G 7

Pocono group :		
5. Massive, gray sandstone,	100'	353'
6. Layer of conglomerate with breccia of shale and sandstone,	2'	
7. Greenish shale,	1'	
8. Sandstone, gray massive,	55	
9. Concealed,	50'	
10. *Red shale*, sandy, visible,	10'	
11. Concealed,	5'	
12. Massive, coarse, greyish-white conglomerate,	45'	
13. Gray sandstone, few pebbles,	30	
14. Sandstone, shaly, and concealed,	25	
15. Massive sandstone, gray, with large quartz pebbles at bottom, base of *Pocono No. X*,	30'	
		586'

The Campbell's Ledge black slate, No. 2, has yielded a large number of organic remains, principally plants. For the following list I am indebted to Mr. R. D. Lacoe, of Pittston, under whose supervision the species mentioned were collected from a single locality where seemingly not more than two or three cubic yards of the black slate have been excavated.

The species marked thus * are as yet unpublished, but will appear in Prof. Lesquereux's forth-coming Volume II of the Coal Flora. The identifications are all on the authority of Prof. Lesquereux:

Alethopteris Serlii, Br'gt.
Pecopteris longifolia, Brgt.
" serrula, Brgt.
Pseudo-pecopteris nervosa, Brgt.
" Sillimani, Brgt.
" glandulosa, Lsqx.
" irregularis, St.
" nummularia, Gutb.
" Loschii, Brgt.
Sphenopteris furcata, Brgt.
Sphenophyllum Schlotheimi, Brgt.
" emarginatum, Brgt.
Calamites ramosus, Artis.
" ramifer, St.
Asterophyllites longifolius, Brgt.
" sphenophylloides, Zenk.

* Lycopodites simplex, Lesqx.
Lepidodendron Veltheimianum, St.
" Rushvilliense, Var. Andrews.
" modulatum, Lesqx.
" Sternbergi, Brgt.
Lepidostrobus hastatus, Lesqx.
" variabilis, Lu. & H.
* Lepidophyllum lineatum, Lsqx.
* " gracile, Lsqx.
" lanceolatum, Lu. & H.
* Campbellianum, Lsqx.
* sp ?
Lepidocystis vesicularis, Lsqx.
" fraxiniformis, Goepp.
" bullatis, Lsqx.
Sporocystis planus, Lsqx.
Spirangium intermedium, Lsqx.
" multiplicatum, Lesqx.
" appendiculatum, Lsqx.
Cordaites grandifolius, Lsqx.
" borassifolius, St.
" Lacoei, Lsqx.
*Cordaianthus, flexuosus, Lsqx.
" spicatus, Lsqx.
" rugulosus, Lsqx.
Cardiocarpus, annulatus, Newb'y.
" pachytesta, Lsqx.
" latus, Newb'y.
" elongatus, Newb'y.
" zonulatus, Lsqx.
" late-alatus, Lsqx.
" simplex, Lsqx.
" diminutivus, Lsqx.
" fasciculatus, Lsqx.
" apiculatus, G. & B.
" regularis, St.
" congruens, Grd' Ey.
Rhabdocarpus, Jacksonianus, Lsqx.
" multistriatus, Presl.

Rhabdocarpus, Danai, Foster.
" amygdalaeformis, G. & B.
" late-marginatus, Schimp.
" minutus, Lsqx.
Trigonocarpus, juglans, Lsqx.
" acuminatus, Lsqx.
" retusus, St.

In addition to these 63 species of *plant remains*, Mr. Lacoe has found six species of *fossil insects* in the same bed, belonging to the genera *Miamia*, *Haplophlebium*, *Euphemerites*, *Gereblattina*, and *Archymilacris*. *G. fascigera*, and *A parallelum* are described from this bed by Mr. Scudder in "Palæozoic Cockroaches," Boston Soc. Nat. History, Vol. VIII.

Mr. Lacoe also adds, "*Spirorbis carbonarius*, Du. is common, attached to plants, and a few poorly-preserved *shells* have been obtained from a stratum in the lower half of the shale, under the principal plant-bearing layers.

The insects were found in the upper portion of the plant layers, the extreme upper and lower portions of the bed being quite barren; the former, coarse, sandy; the latter, fine, soft, clayey."

From the foregoing list of fossils it will be seen that while a few forms like *Lepidodendron Veltheimianum*, *L. Rushvilliense*, and a few others, recall *sub-carboniferous types*, the great majority belong to species which are known only from the *Pottsville conglomerate.*

The dividing line between Carboniferous and Sub-carboniferous may be drawn at the base of No. 3, a very hard grayish-white sandstone, containing no pebbles, but totally different in its lithological character from anything else in the *Mauch Chunk beds* at this locality.

The following succession observed on the south side of the river, opposite West Nanticoke in Luzerne county, would seem to bear the same signification:

Section Opposite West Nanticoke (Fig. 2, page 38.)

1. **Massive, coarse, pebbly conglomerate, visible, ... 100'**
2. **Drab, sandy shale, ... 4'**

3.	*Black slate and coaly shales*, (Campbell's Ledge bed,)	10'
4.	Sandstone, *creamy white*,	3'
5.	Green shales of the *Mauch Chunk*,	—

No. 3 was not examined for plants at this locality but its stratigraphical relations show it to be unquestionably identical with the *Campbell's Ledge bed;* while directly below it comes a bed of *whitish sandstone* totally unlike any of the genuine *Mauch Chunk beds* below; for, the sandstones in the latter are always tinged with green, while this No. 4 is nearly pure white, like the *Pottsville beds.*

The Campbell's Ledge black slate is often absent, however, having been eroded or else never deposited; and in that case the thin *white sandstone* below it is usually gone, so that the great *pebbly member* of the *Pottsville* then rests directly on the *Mauch Chunk beds.*

The Forkston Coal bed.

A bed of coal has been mined for several years by the Forkston Coal Co. in the western portion of Wyoming county, near the line between Forkston and North Branch townships.

The mine is situated in a wilderness near the summit of Dutch mountain, at 2,125' A. T. (Bar.) and about three miles north from the road leading through Bella Sylvia to Dushore in Sullivan county.

The following structure is exhibited at the mouth of the mine:

Section at the Forkston Coal Co.'s bank. (Fig. 3, page 38.)

1.	Very massive pebbly sandstone,			visible 15'
2.	*Forkston coal*,	Coal, good,	2' 0"	3' 2"
		Cannel slate,	0' 4"	
		Coal,	0' 2"	
		Slate and bone coal,	0' 4"	
		Coal,	0' 4"	
3.	Dark sandy shale,			5'
4.	Concealed,			

This coal is a semi-anthracite, although the rocks are practically horizontal and the coal is undisturbed. It has been mined back under the crest of the mountain for several hundred yards, and furnishes a very fair fuel which supplies Forkston village and a large region around it.

A sample of the coal analyzed by Mr. McCreath exhibited the following composition:

Water,	.612	
Votatile matter,	10.238	
Fixed carbon,	73.480	
Sulphur,	.745	
Ash,	14.925	Color of ash, white.
Total,	100.00	

"The coal does not have the slightest tendency to coke."

The specimen forwarded for analysis was of the average quality.

This coal underlies several hundred acres along the western margin of Wyoming county, near the center of the *Bernice syncline*, and if any means of R. R. transportation were at hand might prove, when better developed, of considerable economical importance.

With regard to the geological horizon of this coal, I feel some uncertainty. On botanical grounds I am inclined to believe that it represents the *Campbell's Ledge black slate* horizon.

Mr. Sherwood, in his geological map of Wyoming county, colors the region where it occurs as if the rocks were *Pocono sandstone No. X*, but on what grounds I am not informed. What evidence I could obtain points to the *Carboniferous age* of the bed in question.

My own belief is founded solely on the nature of the as-associated *plant remains*. In the conglomerate roof of the mine I saw several casts of *Sigillaria trunks* nearly two feet in diameter, and so far as I know such large specimens of this genus have never been found in the Subcarboniferous beds of Pennsylvania.

In the shale below the coal I observed a small *Neuropteris*, a *Cardiocarpus*, and a *Cordaites*, all of well marked *Pottsville conglomerate facies*, and such as I have never seen from the *Subcarboniferous*. I have therefore very little doubt that the *Forkston coal* comes at the same geological horizon as the *Campbell's Ledge black slate*—viz: at the very base of the *Pottsville conglomerate.*

The base of the *Pocono sandstone* occurs at only 300′

below the coal, and this would militate against my view of its age; unless we admit a thinning away of 200′ for the *Subcarboniferous beds* northward from the region of Campbell's Ledge, 25 miles south-east from the Forkston coal locality; which in fact is just what should be expected on receding from the anthracite coal measures, a region of thick deposits.

Another objection to my view should be stated: No. 1 of the Forkston section has not the typical lithological characters of the *Pottsville conglomerate*, its pebbles not being quite so ovoid as usual in the latter, and the rock itself hardly as massive as the basal member of the pebbly *Pottsville* in adjoining regions.

[But a third objection is still stronger, viz: that in the Lehigh region, and elsewhere, there are coal beds in the body of the *Pocono formation No. X*, hundreds of feet beneath the *Pottsville conglomerate No. XII*. Therefore until the plant remains of these beds shall have been better studied, the palæontological argument in the text lacks force.—J. P. L.]

The Mauch Chunk Shale, (No. XI.)

The red shales which characterize the *Mauch Chunk formation* over a wide area of the Pennsylvania Carboniferous, thin out toward the north-eastern corner of this district, and disappear entirely along the northern rim of the Lackawanna coal basin, before the latter crosses the North Susquehanna river at Pittston, leaving only 150′ of *greenish shales* and *flaggy sandstones* (as shown in Section 1) to be referred to the Mauch Chunk beds.

So far as the lithological aspect of these beds is concerned, they might with nearly equal propriety be included under the *Pocono*, for not a trace of *red shale* could be found in the entire 150′. Other considerations, however, render it certain that the 150′ of green beds under the *Pottsville conglomerate* in Section 1 should be classed with the *Mauch Chunk*; for

(1°) When the *red shales* begin to make their appearance in the *Mauch Chunk* a few miles (3–4) south-west from

Campbell's Ledge, they do not come in as a mass on top of these green and greenish gray beds, but interleave with them as knife edges between the layers of the green beds, many of which subsequently change gradually into *red rocks*, when the *Mauch Chunk* thickens up toward the south-west.

(2°) The massive, yellowish sandstone which always begins the top of the *Pocono* in this district, comes in *beneath* the green beds at Campbell's Ledge.

The Mauch Chunk rocks continue to thin away north-east from the locality of Section 1; so that where Leggett's creek breaks through the Lackawannock mountain in Lackawanna county above Scranton, they have decreased to 75′, in which not a single *red layer* is to be seen.

This north-eastward disappearance of the *red beds* from the *Mauch Chunk*, and the consequent thinning away of the series to almost nothing towards the northern end of the *Lackawanna coal basin*, also takes place on the south side of it, in Wayne county, as was shown in Report G⁵.

The Mauch Chunk shale increases in thickness gradually toward the south-west, through Kingston and Plymouth township of Luzerne county; the *red beds*, as already stated, interleaving as knife edges with the green layers; the whole mass rapidly swelling out to many times the thickness which it has at the north-eastern corner of Lackawanna county.

The red beds are noticed coming in at the gaps of Abraham and Toby creeks, in Kingston township; while at Nanticoke, in Plymouth township, fourteen miles west from Campbell's Ledge, the *Mauch Chunk* has thickened up so as to exhibit the following structure:

Section opposite West Nanticoke (Fig. 4, page 38.)

1. ***Pottsville conglomerate***, **massive,**			—
2. Shales, drab, sandy,			4′
3. Black slate and coaly shales, (Campbell's Ledge bed,)			10′
4. Whitish sandstone, (base of XII,)			3′
5. Green shale	10′	*No. XI.*	425′
6. Sandstone, green flaggy,	100′		
7. Green shale, sandy interleaved with *red*,	100′		
8. *Red shale*, sandy,	215′		
9. *Pocono sandstone No. X*,			—

Westward from Nanticoke the Susquehanna river flows along the strike of the *Mauch Chunk shale* and has eroded so much of it to form its bed that no opportunity for measuring its thickness occurs until the river turns southward at Shickshinny, 8 miles west from the locality of the last section. Here, on the south side of the *Wyoming basin*, the *Mauch Chunk beds* have a thickness of about 1200′.

This shows a thickening from Nanticoke south-westward of nearly 100′ to the mile.

The Mauch Chunk beds extend from Shickshinny westward in the narrow trough of the Wyoming basin, between two mountains of *Pocono* until the latter come together near the eastern line of Columbia county.

In Catawissa Valley the *Mauch Chunk red shale* surrounding McAuley mountain has a thickness of not less than 2000′.

These beds also make the valley between Little (No. X) and Big (No. XII) mountains across Northumberland and the southern point of Columbia; and a similar valley through Northumberland county on the south side of the Shamokin basin. Here the thickness cannot be less than 2000′ and may possibly reach 2500′, of which much the larger part is *red shale.*

The Pocono sandstone beds No. X.

The line between the *Mauch Chunk* and the *Pocono beds* of this district is very definitely marked except along the north-eastern end of the *Lackawanna coal basin,* where the *red shales* have disappeared from No. XI; but even then a considerable change in the lithological character is evident at the top of the *Pocono,* so that there is little danger of mistaking the rocks of the one for the other.

The Pocono usually begins at top with a very hard, grayish, or yellowish white sandstone in layers 1′-3′ thick, which sometimes contains small pebbles. This sandstone is 100′-200′ thick, and nearly always juts out of the hills in great cliffs since it is the first to reach the summits. This portion of the series makes the high cliffs which crown the

Lackawanna mountaina at the gap of the river opposite Coxton; and the gaps of Toby, Hunlock, and other creeks.

Beneath this uppermost sandstone lie gray and green sandstones inter-stratified with occasional beds of shale, one of which is often *red.*

The Pocono beds are terminated below by a massive, gray, and yellowish white, very coarse conglomerate, which being usually quite different from anything to be found further down in the series defines sharply the lower limit of the *No. X rocks.* It seems to represent the *Griswold's Gap conglomerate* of Wayne county, (described in my Report G⁵).

In Section 1 at Campbell's Ledge the *Pocono beds* have a thickness of about 350′, and the *Griswold's Gap conglomerate* is represented by Nos. 12, 13, 14, and 15, making altogether 130′ of rock. Of these the uppermost (No. 12) is by far the most pebbly and massive, and in some portions of the region (Wyoming Co.) seems to be the solitary representative of the *Griswold's Gap group.*

A very good quarry sandstone is sometimes found at the extreme upper limit of the *Griswold's Gap conglomerate;* and it was once extensively quarried just below the summit of the mountain east from Coxton. It is there grayish white in color, and works into beautiful blocks of stone, which have been used in buildings at Wilkes-Barre, Pittston, and other towns in the Wyoming valley.

The Pocono sandstones and conglomerates are preëminently the *mountain makers* of the district—all the mountains and high tablelands of western Wyoming; the long high wall of North (Allegheny) mountain; the northern and southern mountain rims of the Wyoming coal basin; the Nescopeck, Catawissa, Little, Line, and other mountains in Columbia and Northumberland counties, are all made by these massive beds.

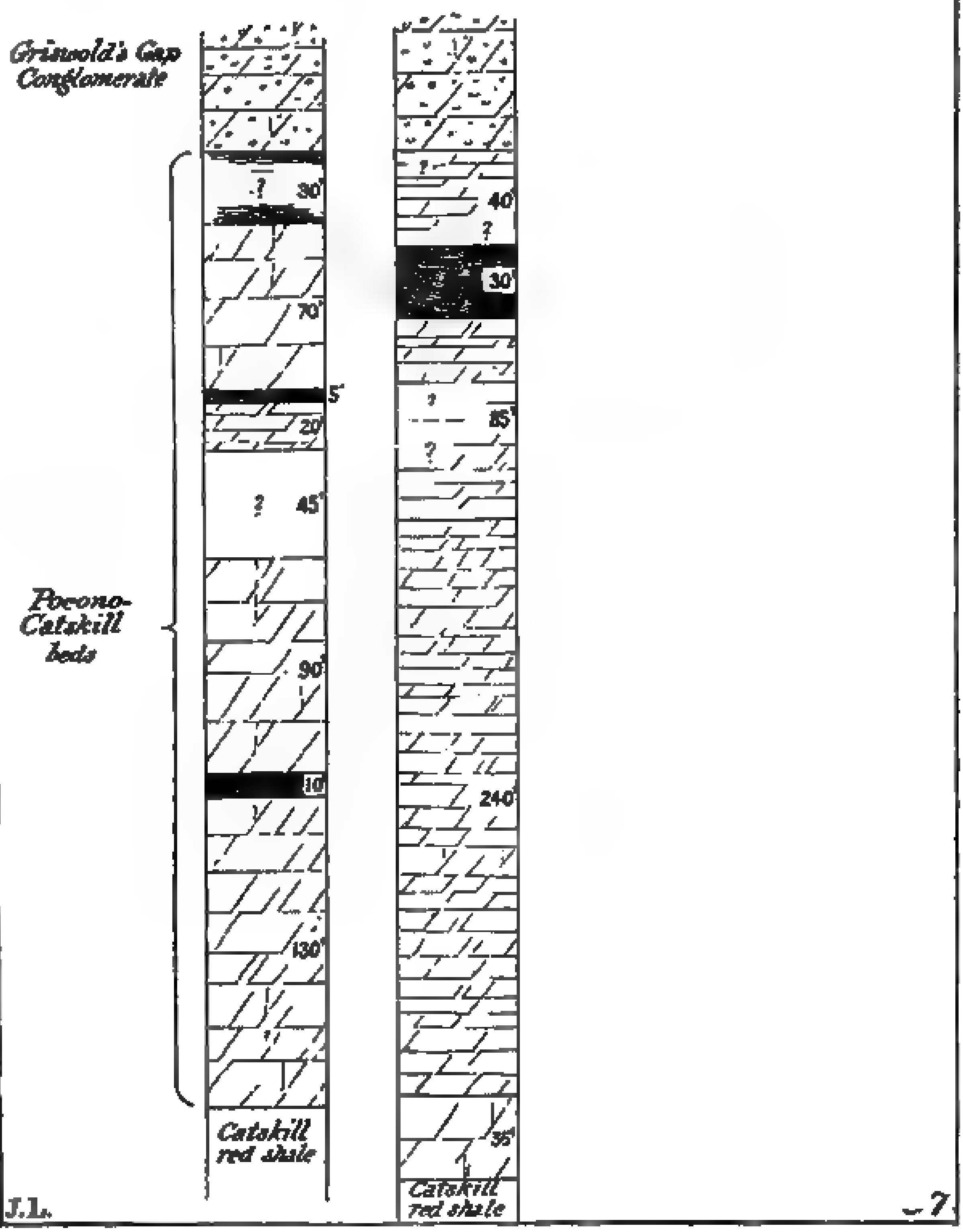
The Pocono rocks also increase in thickness from the northern end of the Lackawanna coal basin south-westward, but not so rapidly as those of the *Mauch Chunk.* They are about 600′ thick at Shickshinny, and the same in Nes-

Plate I.

Catskill-Pocono rocks.

Fig. 8.
Nescopec Mtn.

Fig. 5. Lovelton. | Fig. 6. Long Pond. | Fig. 7. Campbell's Ledge.



copeck mountain to the south, as seen at the gap of Catawissa creek, near Mainville.

Southward from Nescopeck mountain they continue to increase in thickness; being 700–800′ thick, as measured in the gaps of Bear and Shamokin creeks, where they stand upon their edges in Little Mountain.

The Pocono, when thickest, seems to consist throughout of coarse and often pebbly, gray and yellowish gray sandstones, many of which are quite massive, (20′–30′ thick,) and separated by beds of shaly or flaggy sandstones.

The Pocono holds some thin *streaks* of *coal* near the head of Bowman's creek, one having been reported to me as 6″–8″ thick. Some *thin and irregular bands of coal* also occur in this formation along North mountain near the line between Columbia and Luzerne, and thousands of dollars have there been spent in exploring the rocks for *coal* and other minerals, where it is certain that nothing of that nature will ever be found in paying quantities, however much money may be expended in the search.

The hard *Pocono sandstones* have furnished a large proportion of the bowlders of both the original and the transported *Drift*.

The Pocono-Catskill group.

Under the above name it has been found necessary to class a group of rocks which lie beneath the *Griswold's Gap conglomerate*, extending down to and including the *Mount Pleasant conglomerate.*

The beds belonging at this horizon I described in G' under the title of "*Transition series*," because they seemed to combine some of the characters of both the *Pocono* and *Catskill rocks.* The study of this portion of the column of rocks over a much wider area during the summer of 1882 has tended to confirm my original opinion of them as an intermediate or *transition group*, *i. e.*, beds of passage from No. IX to No. X.

The group as a whole is composed largely of green and greenish-gray sandstones, interstratified with which are

often found thin beds of *red shale*, and a considerable bed of the latter often occurs at the top of the group.

When the rocks of this group become massive they take on a *Pocono aspect*, becoming coarse, gray, and even pebbly, while the *red shales* almost completely disappear from them. On the other hand, when the same beds become shaly or less massive the sandstones assume the peculiar greenish-gray characteristic of the *Catskill rocks*, while the *red beds* increase in thickness and number. The geologist unacquainted with their changing type would at one time place them unhesitatingly in the *Pocono*, and at another would feel sure that they belonged in the *Catskill* series.

The thickness of the group in this region varies between 300′ and 500′. It is rather sharply cut off from the undoubted *Pocono* above by the large pebbled grayish-white *Griswold's Gap conglomerate;* and from the genuine *Catskill* below by the cessation of the *large beds of Catskill red shale*, and often by a deposit of very massive sandstone frequently containing small pebbles, (*Mt. Pleasant conglomerate.*)

The Pocono type of these beds is well illustrated by the following section from North Branch township, Wyoming county, taken on the northern flank of Dutch mountain above Lovelton:

Catskill-Pocono beds near Lovelton (Fig. 5, page 48.)

1.	*Griswold's Gap conglomerate,*		—
2.	Concealed (shale,)	30′	400′
3.	Gray, massive sandstone,	70′	
4.	*Reddish, sandy shale,*	5′	
5.	Sandstone, gray,	20′	
6.	Concealed,	45′	
7.	Sandstone, massive, gray, and greenish,	90′	
8.	*Red shale,*	10′	
9.	Sandstone, gray and greenish, rather coarse and massive,	130′	
10.	*Catskill red shale,*		—

Another type of these beds is shown along the Berwick pike which descends North Mountain from Long Pond at the north-western corner of Luzerne as follows:

Section along the Berwick pike, (Fig. 6, page 48.)

1.	*Griswold's Gap conglomerate,*		
2.	Sandstone, gray, and concealed,	40′	430′
3.	*Red shale,*	30′	
4.	Gray sandstone and concealed,	85′	
5.	Sandstone, gray and greenish gray,	240′	
6.	Sandstone, greenish gray,	35′	
10.	*Catskill beds,*		

As an example of the *Catskill* type of the group, the succession seen beneath the *Pocono beds* of Sec. 1 at Campbell's Ledge may be cited:

Campbell's ledge section, (Fig. 7, page 48.)

1.	*Griswold's Gap conglomerate,*		
2.	Shales, sandy, green and red,	100′	300′
3.	Sandstone greenish gray, typical *Catskill sandstone,*	50′	
4.	Shale, green, streaked with red,	20′	
5.	Sandstone in massive beds, gray and greenish gray, current bedded,	130′	
6.	*Catskill red shale,*		

The relation of these beds to the *Pocono sandstone* is shown in the gap of Catawissa creek through Nescopeck mountain, in Maine township, Columbia county:

Section near Mainville (Fig. 8, page 48.)

1.	*Mauch Chunk red shale,*			
2.	Sandstone, coarse, gray, yellowish,	30′	*Pocono.*	580′
3.	Concealed,	250′		
4.	Massive, grayish white, conglomerates in several beds,	300′		
5.	Gray sandstone, shales, and concealed with massive gray sandstone at base,	300′	*Pocono-Catskill.*	375′
6.	Sandstone, gray above, passing down into reddish beds at base,	75′		
7.	*Catskill red shale,*			100′

In Little mountain, at Bear gap, and Shamokin gap, the combined thickness of the *Pocono* and *Pocono-Catskill beds* is about 1,200′ of which probably 500′ should be considered as belonging to the latter.

In my section from Carbon county, below Mauch Chunk, published in G[6] page 79, it is very probable that the *500′ of red shale*, and the two great conglomerates below it (making

together 900′ of rock) should be classed with this group, and not with the *Mt. Pleasant red shale*, and *Cherry Ridge conglomerates* to which they were there referred.

The small band of *red shale* often occurring near the top of the *Pocono-Catskill* in this district, would then represent the *500′ red beds* below Mauch Chunk which in G[6] were considered the top of the *Catskill.*

Chapter IV.

The Devonian rocks.

The formations represented in the *Devonian* of this district are the *Catskill*, *Chemung*, *Hamilton*, and possibly a thin representative of the *Cauda-Galli grit;* the *Corniferous beds* being certainly unrepresented; while the *Portage* is so poorly defined that it has been included under the *Chemung*.

Devonian rocks cover more than three fourths of the area of the district.

The thickness when fully exposed to view varies between 8000 and 9000 feet; though it is probable that a shaft sunk through the entire system at the northern line of Wyoming (where only the upper portion is open to inspection), would not be more than 6000 feet in depth, since the *Catskill beds* thin away rapidly in a northward direction.

Although these rocks have such a great thickness, and spread over so large a portion of the district, they contain no valuable minerals of any description, in paying quantities. Much useless search has been made in these rocks for *Lead*, *Silver*, and *Copper;* but it can be confidently predicted that none of these will be found in paying quantities within the *Devonian rocks* of this district, and the money and time spent in searching for them will be totally wasted. Small scattered crystals of *galena* may be found almost anywhere in the *Devonian system;* and traces of *Copper* are abundant in the *Catskill;* but always in such meager quantities with both metals that any attempt at mining either would be disastrous.

This statement does not apply to the *Lead and Zinc ores* occurring at the base of the *Lower Helderberg limestone* near Espy and Sunbury, since these do not occur in the *Devonian system;* and appropriate reference will be made to them in the next chapter.

It is remarkable that in a series of rocks of such great thickness, exposed over a region so large, no valuable *iron ores* should be found; and yet it is certain that such do not exist, even at the well known *ferriferous horizon* at the base of the *Marcellus.*

Since the *Devonian rocks* cover so much of the region, their decomposition has furnished the principal portion of the farming lands of the same, but the nature of the soil made by each will be referred to under the detailed description of the different sub-divisions which follow:

The Catskill series.

The Catskill rocks are rather sharply separated at top from the *Pocono-Catskill beds* by the occurrence of *red shales* of considerable thickness, and a type of greenish gray sandstone which, save in exceptional cases, I never find in any of the overlying rocks in this region. But while the *top* of the *Catskill* can nearly always be definitely determined, it is not so with its *base* in this region; for there comes in at the bottom of the Catskill a series of rocks having such a mixture of *Catskill* and *Chemung characters* that it seems impossible to determine precisely the lower limits of the former, or the upper of the latter; and to bridge over the difficulty I have thought best to classify these *transition beds* as an intermediate *Catskill-Chemung* group.

The base of the Catskill series, as limited in this report, has been placed at the horizon where the *scales, teeth,* and *bones* of *Holoptychins* make their first appearance; and although this would seem like a very arbitrary line, since these *remains* may possibly hereafter be found in lower beds than heretofore, yet in the absence of anything better this must be used as my basis of classification. Luckily, in the region of this report the *lowest fish bed* comes at the horizon of a considerable thickness of *red shale.*

It is probable that a better classification (better, at least, in the sense that it would be more definite,) could be made by neglecting the *fossils* and basing it entirely on lithology. If this method were pursued, the base of the *Catskill* would

be fixed by the *lowest red bed*, and then there could be no danger of mistake, in this region at least, since this *lowest red bed* makes its appearance everywhere at about 2,300′–2,400′ above the top of the *Hamilton;* and no other red beds are noticeable until we get down to the *Salina*, about 5,000′ lower.

Should future research establish as a fact that the *oldest red bed* in the *Devonian system* lies over wide areas of the State at about the same geological horizon, it may then become preferable to consider it as the base of the *Catskill rocks* instead of the arbitrary lines hitherto drawn wherever the lowest *fish beds* happen to be found.

The thickness of the Catskill No. IX varies greatly, thinning from a maximum of 4,500′ in the southern portion of the district to about 1,800′ at the north line of Wyoming county, *i. e.*, excluding from it the rocks which have been placed in the *transition Catskill-Chemung group.*

The rocks of this series prove so variable when traced southward through the region that it was found impossible to keep hold of all the sub-divisions that were established for Wayne and Susquehanna counties in 1880; for when the rocks thicken so enormously the intercalated members so change the general aspect of the series from what it presents when only 1500′–2000′ thick, that the identifications become extremely problematical; although some of the larger divisions, like the *Montrose red shale*, may be confidently recognized in nearly every section.

The character of the rocks, however, is very changeable; since in one section more than two thirds of the whole series may be massive-looking, greenish sandstones, with only thin beds of *red shale* interstratified; while only a few miles distant the green sandstones disappear and in their stead are found very thick *red beds*.

The worm-eaten appearance described by Prof. Stevenson in T[a] as characterizing the *Catskill rocks* of Bedford and Fulton counties, I also noticed in the *red beds* of this district and occasionally in some of the greenish shaly rocks also.

The following section, compiled from the vicinity of Cat-

Plate III

Fig. 9. The Catskill Formation, No. IX.
Compiled section at Catawissa.

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awissa exhibits so far as exposures could be obtained, the general character of the *Catskill beds* in Columbia county:

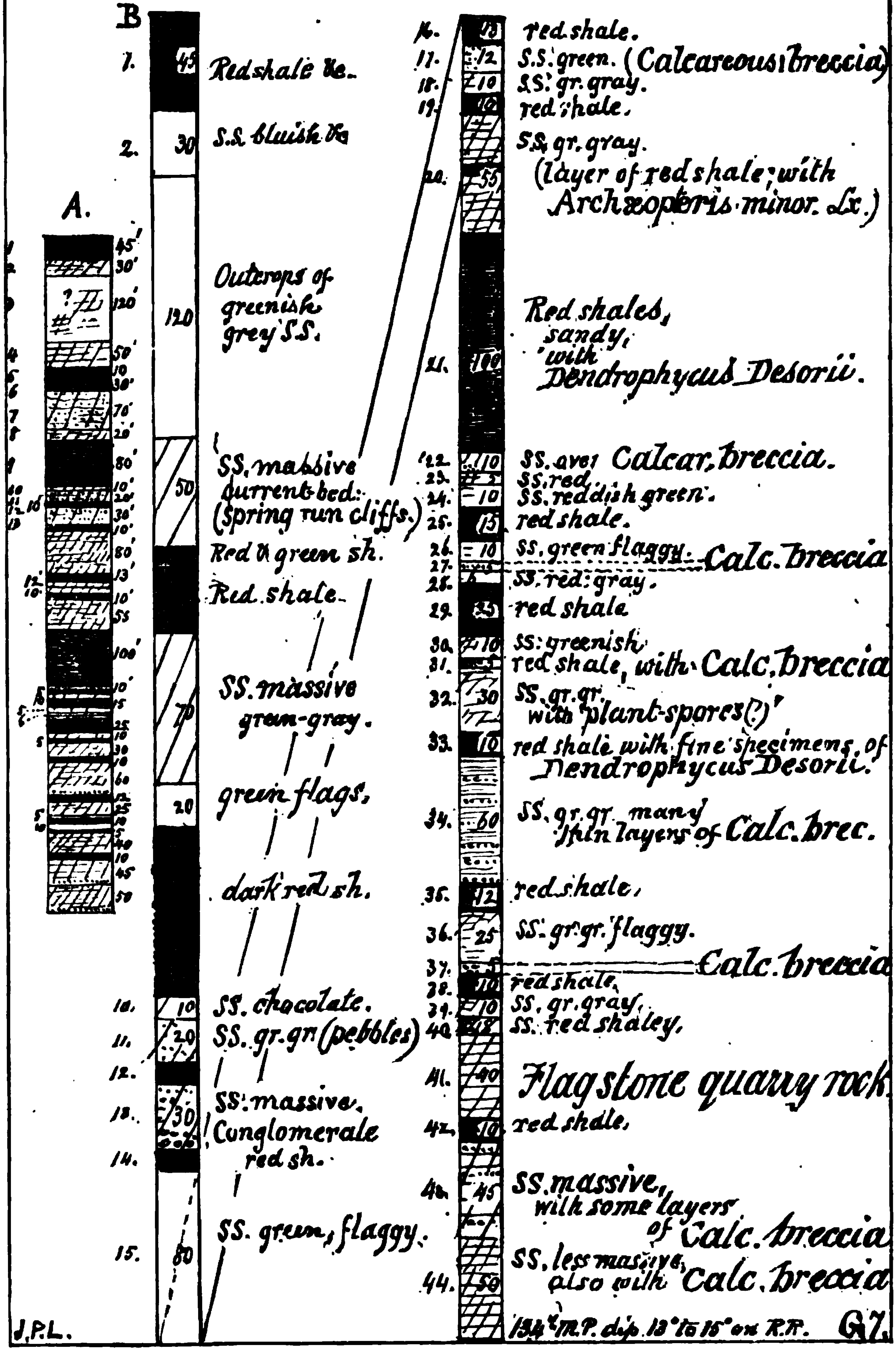
Compiled section near Catawissa (Fig. 9, page 56.)

1.	POCONO-CATSKILL beds,	——
2.	*Red shale,*	100′
3.	Sandstone, greenish gray,	15′
4.	*Red shale,* with a few thin bands of green sandstone,	100′
5.	Sandstone, greenish gray and yellow,	30′
6.	*Red shale,*	35′
7.	Concealed,	100′
8.	*Red shale* sandstones and concealed,	2,000′
9.	*Red shales* with greenish-gray beds and concealed,	600
10.	*Red shales,*	50′
11.	Sandstones, greenish, massive, visible,	10
12.	Concealed,	110′
13.	Sandstone, massive, greenish gray,	20′
14.	*Brecciated limestone; fish bed,*	5′
15.	Sandstone, greenish gray,	50′
16.	*Red shales,* somewhat sandy,	300′
17.	Sandstones, greenish gray,	20′
18.	Shales, green, sandy,	10′
19.	Sandstone, greenish, massive,	30′
20.	*Red shales,* sandy,	27′
21.	Olive shale,	10′
22.	Sandstone, greenish,	10′
23.	Shaly sandstone with *Grammysia elliptica* (?) at base,	7′
24.	Shales, olive green, sandy,	15′
25.	Sandstone, greenish, shaly,	45′
26.	*Red shales,*	40′
27.	Sandstone, greenish gray,	50′
28.	*Red shales,* with some sandy beds,	135′
29.	Green shales and flaggy sandstones,	12′
30.	Shales, olive green,	15′
31.	*Spirifer band* containing *Spirifera mesostrialis,* and *S. disjuncta* in large numbers,	0′ 4″
32.	Sandy shales, green,	5′
33.	Shales, olive green,	40′
34.	Sandstone, very hard, greenish gray, containing *coaly streaks,*	30′
35.	Olive, sandy shales, containing *Lingula spatulata, Pteronites chemungensis?* and other poorly preserved fossils,	10′
36.	*Red shale,* sandy,	2′
37.	Olive shales, containing several thin layers of hard, bluish green rocks which hold *Crinoidal fragments* and fragments of *Spirifers,*	110′
38.	Sandstone, quite massive, containing large *fish bones, vegetable fragments* and *pebbles of shale,*	40′
39.	Shales, greenish, sandy,	12′
40.	Sandstone, green,	8′

Fig. 10. (For Fig 11, see Fig 67.)

Section of Catskill rocks north of Coxton.

(Scale of A, 200':1" — of B, 100':1", when reduced.)



41.	Shales, olive,	4′
42.	Sandstone, greenish flaggy,	7′
43.	Shales, greenish,	10′
44.	*Red shales*, sandy,	8′
45.	Sandstone, purplish brown, and green,	17′
46.	Shales, olive green,	12′
47.	*Red shales*, sandy,	13′
48.	Olive shales,	7′
49.	*Red shales*,	8′
50.	Shales, green, sandy,	5′
51.	*Red shale*,	6′
52.	Sandstone, brown,	4′
53.	Shales, olive green,	10′
54.	*Red shale* containing *scales* and *teeth* of *Holoptychius*, *Pleurotomaria* sp? and *Lingula spatulata*. Base of the *Catskill series*,	20′
	Total thickness of the CATSKILL, near Catawissa,	4,330′

Some geologists would doubtless cut off the Catskill at the base of No. 22, and place all of the underlying portion of the section, 700′ thick, in the *Chemung*, because some shells of *Chemung type* occur in these beds; but since more than 1000′ of *red beds* underlie the *fish bed*, No. 54, at the bottom of the section, I prefer the conclusion that a few of the *Chemung shells* lived on, in this region at least, far into the *Catskill period*.

The identification of the remains found in these rocks was made by Prof. Claypole.*

No. 38 is a remarkable bed, containing here large quantities of *fish bones*, some of which are more than one inch in diameter.

Opposite Roaring run water tank, on the D. L. & W. R.R. 4 miles below Catawissa, this stratum becomes a *very coarse quartz conglomerate*, some of the pebbles being 2″ in diameter, but rather flattish; very large *fish bones*, in considerable number, occur in it there also.

It seems to come at about the horizon of the *Lackawaxen conglomerate* of Pike county, a bed which is also locally a very coarse conglomerate and contains many *fish bones*.

Its general stratigraphical position, and abundance of *fish remains* forcibly suggest the *1st Venango oil sand* at

[* Whose Report (F^2) on the Palæontology and Geology of Perry county and Middle Pennsylvania will be published in 1884.]

Warren, and elsewhere, which contains many *fish bones, scales*, &c.

The *teeth* and *scales* found in No. 54 are doubtfully referred to *Holoptychius* by Prof. Claypole owing to bad preservation. The single *tooth* found got broken and partly mutilated in excavating the block which contained it, so that its character was not distinctly exhibited to Prof. Claypole; but, as I saw it before breaking, it exactly represents the tooth of *Holoptychius Americanus*.

The Montrose red shale seems to begin with No. 28, and extends upwards for several hundred feet, possibly more than 1,000′.

At the base of this bed (No. 28), on Catawissa creek near the line between Maine and Catawissa townships there occur great numbers of the curious *Fucoid-like plant* figured by Prof. Lesquereux in Geology of Pa., Vol. II, Part II, plate xxiii, and now called by him *Dendrophycus Desorii*.

The following section, obtained in passing northward along the Lehigh Valley R. R. in the gap of the North Susquehanna above Coxton, in Lackawanna county, (being really the downward continuation of Secs. 1 and 7,) exhibits the *Catskill beds* as they usually appear in Wyoming, North Lackawanna, and north-eastern Luzerne:

Section north of Coxton (*Fig. 10, page 58.*)

1.	*Red shales*, and concealed,	45′
2.	Sandstone, bluish green, and greenish gray,	30′
3.	Concealed with frequent outcrops of greenish-gray sandstone,	120′
4.	Sandstone, massive, current bedded, greenish-gray, makes cliffs along R. R. at mouth of Spring run,	50′
5.	*Red* and green shales,	10′
6.	*Red shale*,	30′
7.	Sandstone, massive, greenish-gray, pebbly in lower half,	70′
8.	Sandstone, green flaggy,	20′
9.	*Dark red shale*,	80′
10.	Sandstone, chocolate colored,	10′
11.	Sandstone, greenish gray with some pebbles,	20′
12.	*Red shale*, sandy,	10′
13.	Sandstone, massive lower portion *conglomeratic* with large quartz pebbles,	30′
14.	*Red shale*,	10′

15. Sandstone, green, flaggy to the 173d mile post,	80'
16. *Red shale*, sandy,	13'
17. Sandstone, green, containing much *calcareous breccia*,	12'
18. Sandstone, greenish gray,	10'
19. *Red shale*,	10'
20. Sandstone, greenish gray, with a thin layer of *red shale* near the middle containing *Archæopteris minor*, Lx.,	55'
21. *Red shales*, sandy, containing *Dendrophycus Desorii*, badly preserved, (MONTROSE,)	100'
22. *Calcareous breccia* with sandstone at top,	10'
23. *Red sandstone*,	5'
24. Sandstone, green, flaggy,	10'
25. *Red shale*,	15'
26. Sandstone, green, flaggy,	10'
27. *Calcareous breccia*,	5'
28. Reddish-gray sandstone,	6'
29. *Red shale*, sandy,	25'
30. Sandstone, greenish,	10'
31. *Red sandy shale and calcareous breccia*,	5'
32. Sandstone, greenish gray, containing agglomerations of small egg-like bodies which Prof. Claypole suggests are *spores of plants*,	30'
33. *Red shale*, sandy, containing fine specimens of *Dendrophycus Desorii*,	10'
34. Sandstone, greenish gray, with many thin layers of *calcareous breccia*,	60'
35. *Red shale*, sandy,	12'
36. Sandstone, greenish gray, flaggy,	25'
37. *Calcareous breccia*,	5'
38. *Red shale*, sandy,	10'
39. Sandstone, greenish gray,	10'
40. *Red*, shaly sandstone,	8'
41. Sandstone, greenish gray, (quarried for flags,)	40'
42. *Red shale*, sandy,	10'
43. Sandstone, massive, greenish gray, containing some layers of *calcareous breccia*,	45
44. Sandstone, not so massive as last, greenish gray, contains some *calcareous breccia*, bottom rises from track of L. V. R. R., opposite 174th mile post, at an angle of 13°-15°,	50'
Total thickness of CATSKILL exposed in the section,	1,231'

Just how much more of the underlying beds at this locality should be included in the *Catskill* cannot be certainly known, since the surface deposits effectually conceal everything from the 174th mile post northward to the crest of the *Watsontown axis*, but there cannot well be more than 500′ and possibly less.

The Montrose red shale is, with very little doubt, represented in part by No. 21.

Mr. R. D. Lacoe, (to whom I am indebted for information respecting the distribution of the *fossil plants* in this section,) states that *marine forms* resembling the genus *Buthotrephis* occur in considerable number and variety from No. 21 down nearly to the base of the exposure.

Archæopteris Hybernica, hitherto known in the United States only doubtfully from a single fragment, occurs in splendid specimens near Meshoppen, Wyoming county, in rocks which belong not far below the base of the above section. (Prof. Lesquereaux is authority for the identification.) With it there is also found another form, with very narrow dentate leaflets, which is probably new.

Ripple markings are very abundant in the lower portion of the *Catskill series*. A magnificent example of these wave-formed markings may be seen at a quarry on the D., L. & W. R. R., 3 miles below Catawissa, where a hard sandstone, dipping southward 45°, has been removed from an underlying red bed, leaving the latter bare over nearly ⅛th of an acre, and this entire surface is completely covered with *ripple marks*.

The Catskill beds cover all of Wyoming county east of the North Susquehanna river, and more than half of the same west of it; all north Lackawanna; and much of north Luzerne.

Columbia county has a broad border of *red* across its northern portion and a narrow belt through Orangeville.

The Northumberland syncline spreads a wide band of *Catskill* across south Columbia, the southern border of Montour; and a narrow band across the middle of Northumberland county.

The Shamokin syncline causes two narrow strips of *Catskill* to cross the southern half of Northumberland; while a narrow border fringes the extreme south boundary.

The Catskill beds, when shaly and weathered down into a rolling topography, make a very good soil, which produces excellent crops of oats, grass, corn, and when enriched

with lime, very fair crops of wheat. When the beds become very sandy, however, and massive green sandstones predominate, the country is barren.

No minerals occur in the *Catskill* in workable quantity. *Some traces of copper* are frequently seen on the weathered surfaces of these rocks, and in the excavation for the approaches to Nicholson tunnel, on the D., L. & W. R. R., considerable nuggets of *copper ore* are reported to have been found, but they were not in sufficient quantity to repay the cost of mining.

Valuable flag and building stones are obtained from the Catskill rocks in Wyoming county, there being large quarries at Meshoppen and Black Walnut. One of the beds at Meshoppen is sawed for ornamental stone work.

In the boring of the Mehoopany Oil Co. near Lovelton, in the north-western part of Wyoming county, the Catskill rocks have a thickness of 1,620′, excluding 400′ of the *Pocono-Catskill group* above, and 710′ of the *Catskill-Chemung group* below.

The Catskill-Chemung group.

As already stated, a series of beds intervene between the base of the *Catskill*, (as limited in Section 9,) and the top of the genuine *Chemung* rocks, which so alternate between *Catskill* and *Chemung types* that I have thought it best to describe them as a *transition group.*

How truly these beds are *transitional in type* will be seen from the following section, which is a continuation downward of Section 9, so perfectly exposed along the D., L. & W. R. R. in western Columbia county, half-way between Rupert and Catawissa stations:

Section between Rupert and Catawissa, (Fig. 11.)*

1. Green, sandy shale, (= No. 46 of Section 67,)	5′
2. Olive green shale, (= No. 47 of Section 67,)	20′
3. Brown sandy bed containing *Crinoidal fragments*, and much broken *shell remains*, (= No. 48,)	2′
4. Shales, olive green, (= No. 51 of Section 67,)	8′
5. *Shales, purple red*, sandy, (= No. 62, etc.,)	10′

*The reader is referred to Fig. 67, in Chapter IX.

6. Shales, olive green,	5'
7. Brown sandstone, flaggy,	15'
8. Brown sandstone, slightly reddish,	4'
9. Shales, olive green,	10'
10. Hard greenish brown sandstone containing *Spirifera disjuncta*,	5'
11. Shales, greenish, sandy,	10'
12. Olive green shale,	10'
13. Sandy shales, and thin beds of brown sandstone which contain *Crinoidal fragments* and *Spirifera mesostrialis*,	8'
14. Olive shales,	5'
15. Sandstone, green,	5'
16. Olive shales,	20'
17. Sandstone, massive, including *coaly fragments*,	10'
18. Shales, dark gray, sandy,	22'
19. Sandstone, green, interstratified with shale,	20'
20. Shales, brown and olive green,	40'
21. Sandstone, greenish,	5'
22. Shale, olive,	3'
23. *Red shale*,	10'
24. *Red sandstone*,	2'
25. Shales, olive green,	5'
26. *Sandstone, red*,	3'
27. *Red shale*,	12'
28. Shale, olive,	28'
29. *Red shale*,	8'
30. Sandstone, greenish gray,	7'
31. Shales, olive,	15'
32. *Dark red shale*,	12'
33. Sandstone, massive greenish,	20'
34. Olive and green shaly sandstones, with some brown beds containing *Crinoidal fragments*, *Spirifers*, and a minute *Tentaculite*, (*T. spicula ?*)	215'
35. Olive shales, sandy,	250'
36. Brown sandy shales, filled with a coarse *Spirifer*, probably *S. disjuncta*,	5'
37. Greenish, sandy beds,	100'
38. Sandstone, containing many *fucoids*,	5'
39. Concealed,	40'
40. Shales, olive green,	5'
41. *Purple red shale* exposed at roadside near mouth of little run 280 rods north from Catawissa station,	10'
Total thickness of CATSKILL-CHEMUNG group,	1,007'

I have taken for the base of this series the *lowest red bed*, No. 41, which by several measurements made independently in different portions of the region I found to lie at about the same horizon above the *Hamilton*, viz: 2,200'–2,500'—never less than the former nor greater than the latter.

It is true that these beds contain some *shells* that are found in the *Chemung;* but all of them belong to forms which elsewhere in the State survive with but slight changes into the *Sub-carboniferous beds.**

The forms observed in these beds, after a very minute examination, have been determined by Prof. Claypole, (including the species found in the base of the overlying Catskill,) to be the following:

Spirifera disjuncta.	*Pteronites chemungensis?*
" *mesostrialis.*	*Tentaculites spicula?*
Grammysia elliptica?	*Pleurotomaria sp?*
Lingula spatulata.	*Crinoidal fragments.*

Three of the forms are doubtfully referred to the species indicated. All of them except *Tentaculites spicula*? pass upward into the rocks above the usually accepted *fish bed* base of the *Catskill*. *G. elliptica* is found 700′ up in the latter. The species all belong to types of great vertical range. Under all these considerations the evidence is certainly not favorable to placing these beds, several of which are *red* in the *Chemung.*

The *red shales* and *greenish gray sandstones* have the peculiar cast of the *Catskill;* but they are interstratified with *olive green shales* which forcibly recall *Chemung*, and with them are imbedded some animals that flourished in the *Chemung.*

The question is not important so long as the *transitional character* of the beds be recognized. If one were compelled to choose, I should say that the appearance of a *new kind of rock* such as *red shale* and *Catskill green* is of more importance for classification than the survival of a few organisms of great vertical distribution, or the occasional reappearance of an old kind of rock such as olive shale.

All objections are obviated by making these beds an *intermediate group;* its base the *lowest red bed;* its top (for the present) the base of the first *red bed* containing *Holoptychius remains;* with a thickness over a considerable area of this district, in its central portion at least, of about 1000′.

On the Delaware river in Pike county, at the eastern line

* See Preface, page xx.

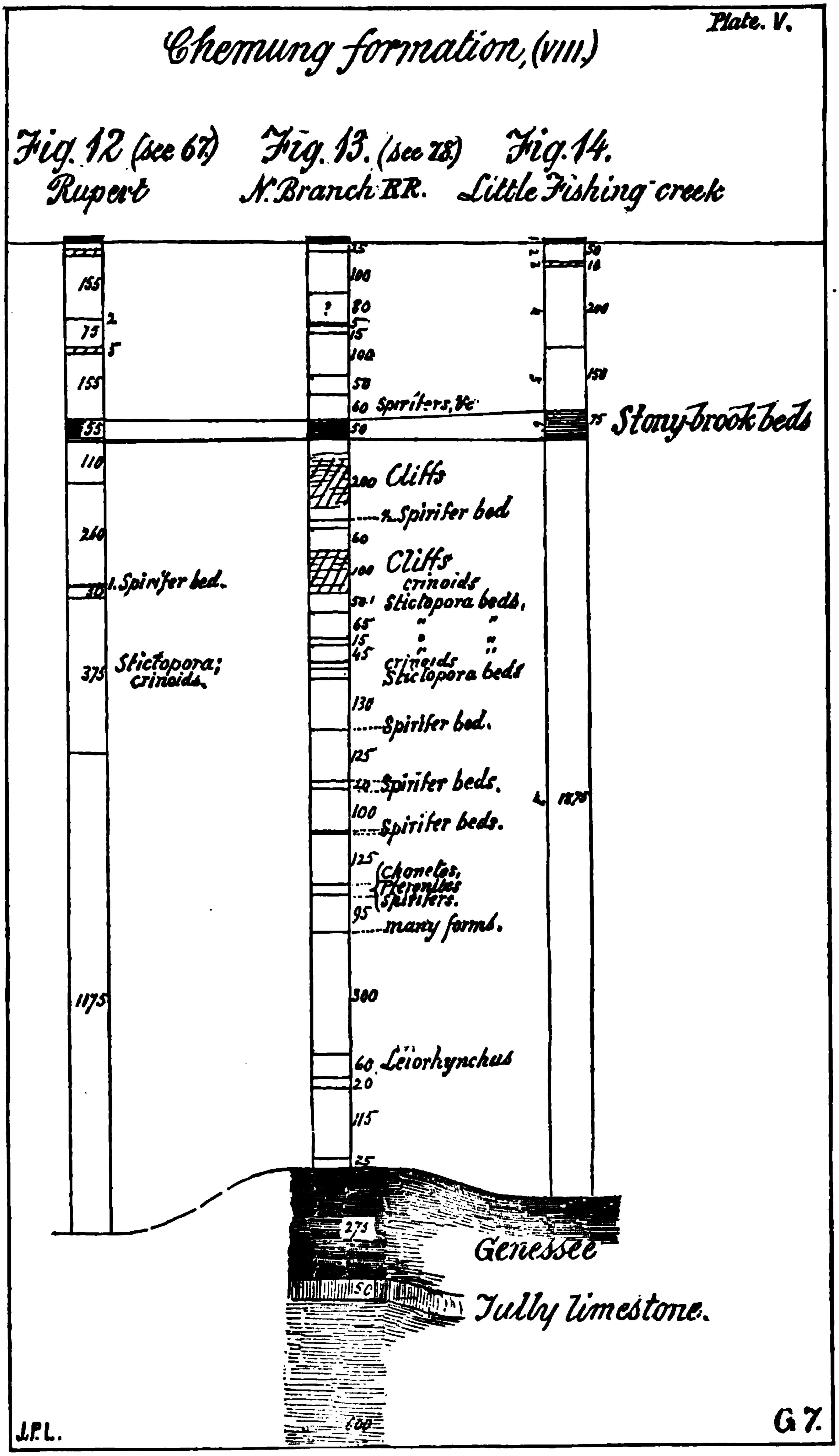


Plate. V.
Chemung formation, (VIII)
Fig. 12 (see 67) Rupert
Fig. 13. (see 78) N. Branch RR.
Fig. 14. Little Fishing creek
Spirifers, &c
Stony brook beds
Cliffs
Spirifer bed
Cliffs
crinoids
Stictopora beds
crinoids
Stictopora beds
Spirifer bed.
Spirifer beds.
Spirifer beds.
Chonetes, Pterinites Spirifers.
many forms.
Leiorhynchus
1. Spirifer bed.
Stictopora; crinoids.
Genessee
Tully limestone.
J.P.L.
G 7.

of the State, the *lowest red bed* was found by me at 2450′ above the *Hamilton*, (see G⁶, page 74.) My measurements in the region of this report vary from 2200′ to 2500′.

In Mr. Chance's section between Lock Haven and Farrandsville in Clinton county, (Report F, Appendix B.) from the *lowest red bed* down to the top of the *Lower Helderberg limestone* is 3728′. My section on Little Fishing creek, Hemlock township, Columbia county, makes it 3546′.

In Bedford and Fulton counties, however, no *red beds* occur in the *Devonian rocks* below Dr. Stevenson's *Chemung lower conglomerate* (Report T².) Hence the rocks of those counties between the two Chemung conglomerates (upper and lower) would seem to come at the horizon. The *Catskill-Chemung* in this district then would represent the interval between his Upper and Lower conglomerates; for I have often found a conglomerate just below the *lowest red bed*, and another (*the Lackawaxen fish conglomerate*) 1,100′ above it.

The Mansfield reds would seem to belong at the base of this *transition group;* and in Wayne and Susquehanna this base would be at the *first red bed* above the *Cascade creek sandstone* of G⁵.

The upper limit in Wayne and Susquehanna would strike above the *Starucca* and *New Milford shales*, and possibly include a portion of the *New Milford sandstones*.

In Pike, Monroe, and Carbon counties (G⁶) this *transition group* would begin with the *lowest reds* and include possibly all of the *Delaware river flags*; the series, as thus limited, having a thickness of 1,100′ on the Delaware river and 1,900′ on the Lehigh.

In Bedford and Fulton, the interval between the *Upper* and *Lower Chemung conglomerates* is placed by Stevenson at about 1,000′.

The Chemung rocks, top of No. VIII.

From what has preceded, the reader will understand that the top of the *Chemung* has been fixed by me in this district at the base of the *lowest red bed*, and that all rocks below this, down to the top of the *Hamilton*, will be de-

scribed under the name of *Chemung*; since I have found it impracticable to separate the *Portage* from the *Chemung* by any well defined characters that would apply throughout the district; although it is very probable that 800′–1000′ of the beds in the lower part of the group are the equivalents of the *Portage beds* in New York.

The following section made along the D. L. & W. R. R. below Rupert, in Columbia county, and which is the direct continuation of Sec. 10, will exhibit the general character and thickness of the rocks which have been included in the *Chemung*:

Chemung rocks near Rupert (Fig. 12, page 66.

1. *Red bed, base of* CATSKILL-CHEMUNG.	
2. Olive green sandy beds,	20′
3. Sandstone, massive, greenish gray,	15′
4. Shales, light olive green,	155′
5. Sandstone, very hard, bluish,	2′
6. Greenish shales, and shaly sandstone,	75′
7. Sandstone, rather massive,	15′
8. Green, olive, and yellowish, sandy beds, sparingly fossiliferous,	155′
9. STONY BROOK *beds*, a series of olive green, sandy shales, and shaly sandstones filled with typical Chemung fossils, the most abundant of which are *Leiorhynchus mesocostale, Productella hirsuta, Spirifera disjuncta, S. mesostrialis*, and *S. mesocostalis*,	55′
10. Greenish gray, sandy beds, fossiliferous,	110′
11, Olive and dark bluish green, sandy beds, shaly above but more massive below,	260′
12. *Spirifer band* (*S. mesostrialis*),	1′
13. Sandy beds, dark green,	30′
14. Dark olive, very hard, sandy beds, containing *Stictopora sp?* and *Crinoidal fragments* in great quantity,	375′
15. Olive, green, and bluish sandstones and sandy shales to base of Chemung opposite canal bridge, near Rupert station,	1175′
16. *Genesee shale*,	
Total of CHEMUNG *beds*,	2443′

This measurement may be relied on as quite accurate, since the beds are almost perfectly exposed along the R. R., which cuts squarely across the strike of the rocks. The *dip* varies but little from 45° S. 10° E. through the entire series, though it occasionally reaches 50° near the base of the same.

The following section taken along the south bank of the North Susquehanna river, beginning at the eastern end of the bridge across the latter stream at Rupert, exhibits the distribution of the *fossils* in the Chemung:

Section along North Branch R. R. (Fig. 13, p. 66).

1.	Red bed, base of CATSKILL-CHEMUNG beds, ...	
2.	Concealed, ...	25′
3.	Soft, olive green shales, ...	100′
4.	Concealed, ...	80′
5.	Sandstone, flaggy, ...	5′
6.	Sandstone, massive, greenish gray, ...	15′
7.	Olive green sandy shales, weathering easily, ...	100′
8.	Sandy olive beds, slightly fossiliferous, ...	50′
9.	Olive green beds with *Spirifera mesostrialis*, ...	60′
10.	STONY BROOK *beds*, very fossiliferous, ...	50′
11.	*Spirifer bed*, ...	½′
12.	Olive, gray, and greenish sandy beds with few fossils, making ragged cliffs, ...	200′
13.	*Spirifer bed*, (*S. disjuncta*), ...	½′
14.	Greenish brown shales, ...	20′
15.	Somewhat shaly, dark olive sandy beds, ...	60′
16.	Dark gray and olive sandstones making ragged cliffs, *Crinoidal fragments* near base, ...	100′
17.	Hard olive sandy beds containing *Stictopora* below middle and *Spirifera mesostrialis* at top, ...	50
18.	Hard, dark gray, sandy beds with *Stictopora*, and *Crinoidal stems* at intervals of 3′–4′ throughout, ...	65′
19.	*Stictopora bed*, ...	½′
20.	Hard, olive-gray beds, ...	15′
21.	Olive, sandy beds, several layers, filled with *Stictopora*, and *Crinoidal fragments*, ...	45′
22.	*Crinoidal layer*, ...	½′
23.	Olive sandy layers, ...	15′
24.	*Stictopora bed*, ...	½′
25.	Hard, olive-gray beds, ...	25′
26.	Layer filled with *Stictopora*, and *Spirifera disjuncta*, . .	½′
27.	Massive, sandy dark olive and gray beds, ...	130′
28.	*Spirifer bed*, ...	1′
29.	Very hard, dark green and bluish olive beds, no fossils seen, ...	125′
30.	Very fossiliferous band, containing *Leiorhynchus mesocostale*, *S. disjuncta*, *Spirifera mesocostalis*, *Orthis impressa*, *Strophodonta Cayuta*, *S. perplana*, var. *nervosa*, *Productella hirsuta*, *Grammysia elliptica*, *Aviculo-pecten pectiniformis*, *Modiola metella*, *Nucula corbuliformis*, *Bellerophon expansus*, *Stictopora* sp? and several undetermined forms; thickness, ...	1′
31.	Bluish gray, sandy beds, ...	20′
32.	*Spirifer bed*, ...	½′

33. Dark olive sandstones, and sandy slates, ...	100′
34. *Spirifer bed*, ...	2′
35. Bluish shales, ...	5′
36. *Spirifer bed* (*S. disjuncta* and *S. mesostrialis*),*	2′
37. Hard, dark olive, sandy beds, ...	100′
38. Dark gray, and olive sandy fossiliferous beds containing at various horizons the following species: *Eodon bellistriatus*, *Cardiomorpha sub-orbicularis*, *Palæoneilo filosa*, *Nucula-lineolata*, *Nucula*, two undetermined species, *Chonetes lepidus*, *Spirifera mesostrialis*, *S. mesocostalis*, *Productella lachrymosa?* and several other undetermined forms including *Stictopora*, .	125′
39. Hard, sandy, gray and dark gray beds, no fossils seen, .	300′
40. Dark gray, sandy beds containing *Leiorhynchus mesocostale*, ...	60′
41. Olive brown beds, sandy, containing *Aulopora tubiformis*, *Orthis tulliensis*, *Chonetes setigerus*, *Nucula lineolata*, *Palæoneilo filosa*, *Pteronites chemungensis*, *Leiorhynchus mesocostale*, *Spirifera mesocostalis*, and *Crinoidal fragments*, ...	20′
42. Olive and dark brown beds, quite sandy, hard, making cliffs, no fossils seen, ...	175′
43. Dark blue, shaly sandstone, with a limy layer at base, .	25′
44. GENESEE SHALE.	
Total thickness of CHEMUNG, ...	2,300′

This section could not be measured so accurately as the previous one, since the R. R. cuts some of the beds quite obliquely; but these were carefully estimated. It is probable that the thickness is about 100′ too small for the whole series, since Section 12, only one mile distant, gave the same beds 2,443′ thick, where they admit of very accurate measurement.

The fossils assigned to the several beds of this section were identified by Prof. Claypole.

Portage.—It will be seen from inspection of the section that some *Portage fossils* occur at the horizons of Nos. 30 and 38, especially *Cardiomorpha suborbicularis*, *Nucula lineolata*, and *Bellerophon expansus*; while with them are found several *Hamilton forms*. It is quite probable that the *Portage* is represented by the beds below No. 30, here about 1,000′ thick; but, as *Leiorhyncus mesoscotale* and *Pteronites chemungensis*, which are usually regarded as characteristic of the *Chemung*, are found within 200′ (No. 41) of the basal beds.

* See Preface, page xx.

Chemung Rocks, (*VIII.*)

The Chemung rocks are finely exposed along Little Fishing creek, in Hemlock township, Columbia county, about one mile above the junction of that stream with Big Fishing, and there the following succession is shown:

Section along Little Fishing Creek, (*14, page 66.*)

	1. **Red shale, base of *Catskill-Chemung group.***	
Upper.	2. **Soft olive shales,**	**50′**
Upper.	3. ***Conglomerate,* gray sandstone, with *flat quartz pebbles,***	**10′**
Upper.	4. **Olive shales, rather soft,**	**200′**
Upper.	5. **Hard, greenish, sandy, flaggy beds,**	**150′**
Upper.	6. ***Stony Brook beds,* very fossiliferous olive-green sandy shales,**	**75′**
Lower.	7. **Very hard, gray, bluish, and dark olive sandy beds,**	**1,875′**
	8. ***Genesee shale.***	
	Total thickness of Chemung,	**2,360′**

In the above section we have a type of the *Chemung* that is found at nearly every point in the district where these beds are exposed,—*i. e.*, the *Chemung* can be divided into two series of rocks quite different from each other in lithological characters, taking the base of the *Stony Brook beds* as the dividing plane.

Upper Chemung.—This is 500′-600′ thick, and consists largely of olive green shale, which readily breaks down when exposed to atmospheric influences, crumbling into small chips and splinters which soon decompose.

No. 3.—*The conglomerate* is not a constant member of the series, but yet it occurs in a great many localities at 30′-50′ below the top of the *Chemung*, being usually a grayish white rock, with small flattish pebbles of quartz scattered through it.

It seems to harmonize well with the *Falls creek conglomerate* of Sherwood in Bradford county; the *Cascade creek sandstone* of Wayne and Susquehanna; and the *Lower conglomerate* of Stevenson in Bedford and Fulton.

No. 6.—*The Stony Brook beds* always remarkably *fos-*

siliferous, are splendidly exposed along the road, at the mouth of Stony Brook, a small stream which empties into Big Fishing creek, 3 miles above Bloomsburg.

Here the base of the beds comes about 1,950′ above the Hamilton. From that locality Prof. Claypole has identified the following species:

Leiorhynchus mesocostale, *Spirifera mesocostalis*, *S. disjuncta*, *Productella hirsuta*, *Chonetes setigerus*, *Strophodonta perplona* var. *nervosa*, *Orthis tioga*, *Atrypa reticularis*, *Cleidophorus oblongus?* *Orthonota* near *siliquoidea*, *Nucula corbuliformis*.

The same beds are finely exposed along the D. L. & W. R. R. opposite the Penna. Canal lock, two miles above Danville, and from that locality the following species were identified by Prof. Claypole: *Productella hirsuta*, *P. hirsuta*, var. *rectispina*, *Spirifera mesocostalis*, *S. disjuncta*, *Leiorhynchus globuliforme*, *L. mesocostale*, *Streptorhynchus chemungense*, *Bellerophon macra*, *Goniatites discoidens?*

The most abundant of these forms are *Productella hirsuta*, *Spirifera disjuncta*, the variety with abruptly sharp pointed wings, *S. mesocostalis* and *Leiorhynchus mesocostale*.

These four species are always associated in the *Stony Brook beds*, and their number is simply countless.

The species at this horizon as will be seen from the lists above given, are comparatively free from any admixture of *Hamilton* forms; in fact this horizon seems to represent, *par excellence*, the typical Chemung rocks of New York in physical aspect as well as in fossils.

This *Stony Brook* horizon can be recognized anywhere within the region wherever its beds are exposed, from Luzerne county to the southern point of Northumberland. It is possible that the same beds may hereafter be traced to more distant parts of the State and serve as a valuable means of comparing equivalent geological horizons; for instance, as far west as Crawford and Erie counties, beds filled with substantially the same fossils are found at 50′–150′ below the *3d Venango oil sand*.

At 50′–100′ above the *Stony Brook beds* there come in frequently olive sandy shales very rich in *Nucula*, *Cleidophorus*, *Avicula*, and *Orthis impressa; Avicula-tricostata* being quite plentiful.

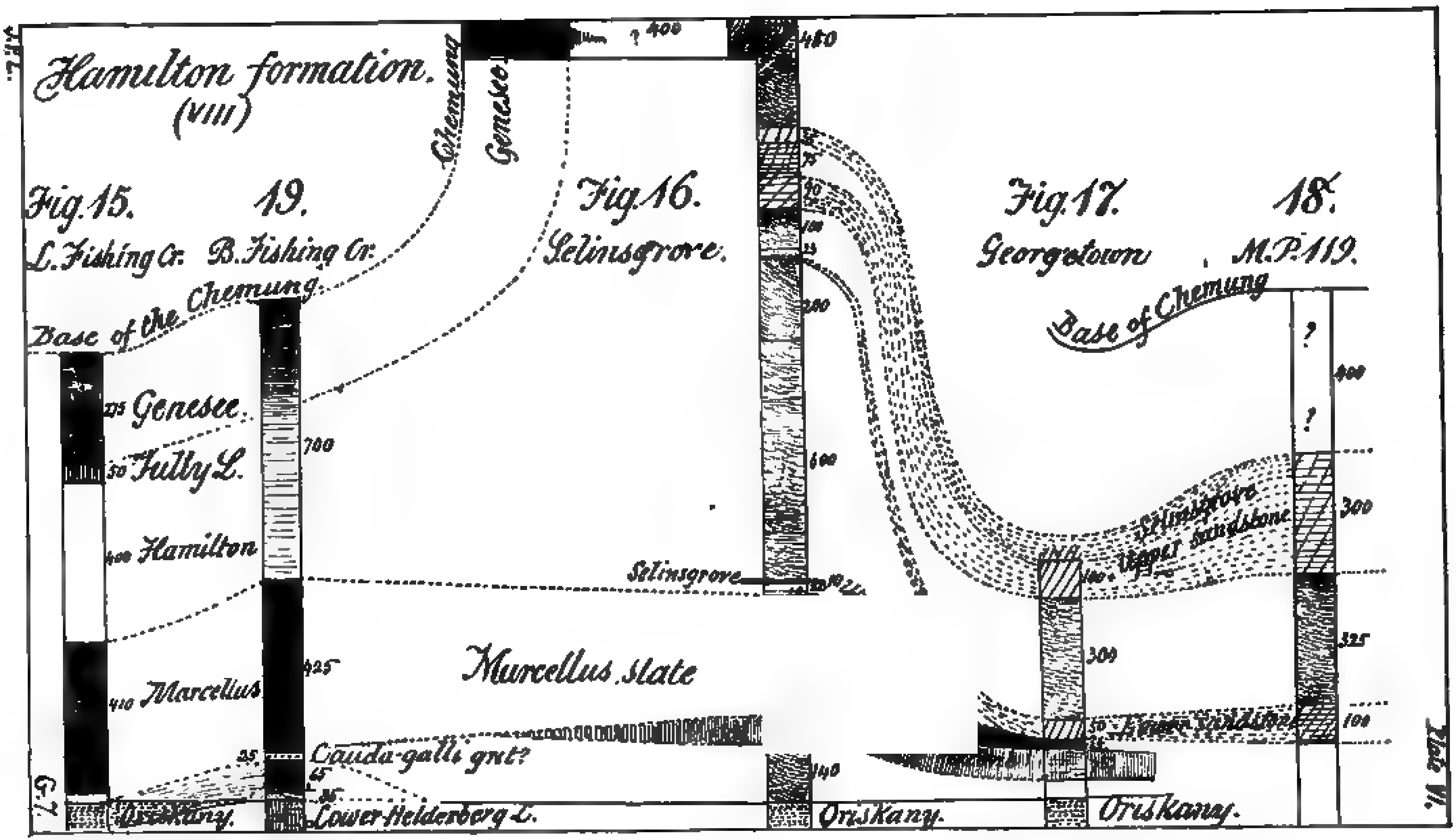
Occasionally the upper half of the beds above the *Stony Brook horizon* becomes quite massive and then takes on the peculiar greenish gray cast of the *Catskill sandstones;* so that it seems probable that the 600′ of grayish green beds at the top of the *Chemung* in Pike and Monroe which in G[6] were referred to the *Catskill*, under the name of *Starucca beds*, may be the equivalent of a portion of the *Upper Chemung* of this district, and therefore erroneously referred to the *Catskill* in G[6]. This seems all the more probable since if this 600′ of beds on the Delaware be added to the rest of the section there, down to the Hamilton, the thickness of the Chemung on the Delaware becomes 2,452′, which is the same as the thickness of the beds in this district between the *lowest red rock* and the *Hamilton.**

Lower Chemung.—All the rocks below the *Stony Brook horizon* may be classed together so far as their *lithological characters* are concerned, since these are practically the same throughout the 1,800′–1,900′ which complete them. They are simply a monotonous succession of dark gray, and dark olive green and brown sandstones, and sandy beds half-way between shale and sandstone, yet so hard as to make high ridges, and a succession of ragged cliffs wherever cut by the streams. In weathering they are usually broken into irregular, and rather thick, splintery-like fragments 4″–6″ long. *The fossils* from the several horizons in these beds have been given under Section 13, above, page 66.

The *topography* that these hard, sandy beds make reveals their presence instantly, and separates them quite sharply from the *Hamilton beds* below, even when the junction of the two is covered.

The base of this series rises suddenly and sharply from the valley of *Hamilton beds*, which always border it, and

* *The lowest red rocks* on the Delaware, cap the 600′ of rocks identified provisionally with the Starucca beds in G[6].



Hamilton formation.
(VIII)
Fig. 15.
L. Fishing Cr.
19.
B. Fishing Cr.
Fig. 16.
Selinsgrove.
Fig. 17.
Georgetown
18.
M.P. 119.
Base of the Chemung.
Base of Chemung
Chemung
Genesee
Genesee
Tully L.
Hamilton
Marcellus
Marcellus slate
Selinsgrove
Selinsgrove upper sandstone
Cauda-galli grit?
Lower Helderberg L.
Oriskany.
Oriskany.
Oriskany.
G.7.
Plate VI.
J.P.L.

usually makes a high ridge of rocky, barren land overlooking the *Hamilton valley* from a height of 300′–400′.

The Hamilton beds in No. VIII.

There is a total and abrupt change in lithology at the base of the *Chemung series*, the hard sandy beds of which give place to dark blue and blackish *Hamilton* shales and slates.

This series, varies so much in character and thickness in passing across the district from north to south as to call for three entirely separate descriptions.

1. Northern type.

The Hamilton beds are fully exposed on Little Fishing creek in Hemlock township, Columbia county, 2 miles north from Bloomsburg. The following section, carefully measured there, may be taken as typical of the formation in the region north of the *Berwick axis:*

Section on Little Fishing creek (15, page 74.)

1. *Genesee slate*, dark blue and blackish shales and slates, sometimes slightly sandy, and when weathered often bleaching gray or even whitish; no fossils observed; thickness 275′.
2. *Tully limestone*, a series of dull gray and bluish gray impure limestones, weathering with a buffish tint, and often presenting a slaty appearance ; usually quite fossiliferous, the following species being frequently present:

   Ambocoelia umbonata, Spirifera Ziczac, S. fimbriata, Orthis vanuxemi, Atrypa reticularis, Chonetes setigerus, Phacops rana, Dalamnites colliteles, Platyceras, sp?, thickness, ... 50′
3. *Hamilton* brown, gray, and bluish-gray sandy shales and slates ; quite fossiliferous, especially its upper half, in which the following species occur :

   Ambocoelia umbonata, Athyris spiriferoides, Tropidoleptus carinatus, Rhynchonella sappho, Orthis vanuxemi, O. penelope, Atrypa reticularis, Spirifera mucronata, S. granulifera, S. fimbriata, S. medialis, Chonetes logani, var. *aurora, Atrypa reticularis, Lingula densa, Discina*

media, *Pteronites decussatus*, *Strophodonta perplana*, *S. demissa*, *Streptorhynchus chemungense*, *Eodon* bellis-triatus*, *Avicula bellistriata*, *Aviculopecten aequilaterus*, *Phacops rana*, *Beyrichia punctulifera*, *Dolmanites collit eles*, *Coleolus tenuicinctus*, *Taenipora exiqua*, thickness, 400′

4. *Marcellus shale*, black and dark-blue fissile slates and shales, sometimes getting gray at base, quite fossiliferous near the top, from which horizon the following species were obtained:

Leiorhynchus limitare, *Ambocoelia umbonata*, *Chonetes mucronatus*, *Discina, sp ?*, *Spirifera, sp ?*, *Pteronites laevis*, *Aviculopecten aequilaterus*, *Orthoceras subulatum*, *Nautilus marcellensis*, thickness, ... 410′

5. *Oriskany sandstone.* ——

Total thickness of Hamilton, ... 1,135′

This type of the *Hamilton series* is remarkably similar to the corresponding beds in Western New York, both in lithology and in the accompanying fossils. The lists given above are from identifications by Prof. Claypole on a collection which I made in less than a day. The number of species might easily be doubled.

The interval from the base of the *Chemung* down to the top of the *Oriskany*, say 1,200′, remains constant, and at every locality where the beds are exposed north of the river the same succession is presented.

No. 1. *The Genesee slate* is remarkably barren of organic remains; the many localities where it has been rather carefully scanned in all parts of the district having furnished but a single individual, viz: a small *Discina*, apparently identical with *D. lodensis* Hall, in the *Genesee beds* of New York.

No. 2. *The Tully limestone* is identified in this region only by its appearance; its fossils, as may be seen from the list above given, are of the common *Hamilton forms*. It may be merely the upper portion of the *Hamilton*; but as the beds immediately above it are certainly the representatives of the New York *Genesee*, there can be no impropriety in referring the limestone to the *Tully horizon.*

This limestone is never pure enough to burn, being us-

[* Cypricardella. J. H.]

ually quite earthy, breaking with a dull, irregular fracture, and often weathering to a light ashen, or even buffish gray color. It is exposed at many localities in the district, but the best places for seeing it are in the cuts of the North Branch R. R., between Mifflinsville and a point opposite Bloomsburg. The fossils given from it in the section above were obtained in a cutting along the North Branch R. R. at the south side of the ferry opposite Bloomsburg. The same fossils occur in this limestone, however, on Little Fishing creek and elsewhere in the district.

Another excellent locality for seeing these beds is along the river road one half mile above South Danville, in Northumberland county.

No. 3. *The Hamilton shales and sandstones*, are finely exposed at the Little Fishing creek locality, having once been extensively quarried there at the "Slate works," where mantels, tables, and other ornamental stone work were manufactured. All of the fossils given under No. 3 were obtained at the *slate quarry*, from the upper half of the exposure, about 100′ below the Tully limestone. A species of *Loxonema*, close to *L. delphicola*, is frequently seen in the *Hamilton.*

The rocks composing this group are mostly sandy shales, and some of the beds might be called shaly sandstones. They are of brown, bluish gray, and olive colors, and frequently contain nodules, or concretions of iron carbonate 1″-3″ in diameter. The more sandy beds are quite hard, and often stand out from the hills in low cliffs.

The Hamilton rocks break up by the action of the elements into slender, irregular splinters 3″-4″ long.

No. 4. *The Marcellus shale* has (in Section 15) been extended down to the top of the *Oriskany;* but possibly the bottom portion really belongs to the horizon of the *Cauda galli grit*, since at some localities beds are intercalated in this portion of the series that exactly resemble the *Cauda galli* in lithological characters; however, as no such beds occur at the slate quarry, it is probable that the whole of No. 4 should be considered *Marcellus.*

All of the fossils found in the *Marcellus shale* were ob-

tained from a layer only 2″-3″ thick, within 50′ of the top of the group. The upper half is a black fissile slate at the slate quarry, while the lower half is a dark blue, and bluish gray shale.

The Hamilton series, as displayed north from the North Susquehanna river, is eminently a *valley maker*, since all of its components, *Genesee*, *Tully*, *Hamilton*, and *Marcellus*, readily break down and disintegrate into soil, the quality of which is excellent, some of the best farms in the district being situated on the Hamilton rocks.

The Susquehanna river flows in a valley of *Hamilton rocks* from Hick's Ferry nearly to Rupert, a distance of twenty miles, and they may frequently be seen extending in low ledges nearly across the bed of the river, notably at Berwick, Beach Haven, Stoneytown, and Bloomsburg.

The Hamilton seems to increase greatly in thickness after passing south from the Berwick axis, if any reliance can be placed on constancy of dip; for the width of its valley along the North Susquehanna in the vicinity of Bloomsburg and other points, would indicate a thickness of 2,000′-2,500′, with a dip of only 30°-35°, which is less than any dips in the *Chemung* above, and less than the dip in the portion of the Hamilton exposed.

Second or Middle type.

The middle type of Hamilton rocks comes in after passing south from the *Northumberland synclinal*, and may be found on either side of the *Selinsgrove arch*, which crosses the Susquehanna river five miles below Sunbury. The section made on the south side of that axis, along the cuts of the N. C. R. R. below Selinsgrove, exhibits a structure for the Hamilton of that region quite different from that shown in Columbia county, and is as follows:

Section below Selinsgrove (Fig. 16, page 74.)

1. *Chemung beds*, ...	
2. GENESEE SLATE, dark bluish, slaty beds, with 4′ of *black slate* at 230′ below top, a single specimen of *Discina lodensis?* seen at 155′ thickness, ...	264′

HAMILTON GROUP.

3. Concealed, ... 400'
4. Olive brown crumbling shales, containing small *iron balls* at several horizons and the fossils *Athyris spiriferoides, Spirifera mucronata, S. granulifera, Tropidoleptus carinatus, Ambocœlia umbonata*, and other forms, ... 450'
5. *Selinsgrove upper sandstone.*
   (a) massive yellow sandstone, coarse filled with *Spirifera granulifera*, ... 35'
   (b) greenish yellow, massive sandstone, . 75'
   (c) *Strophodonta* bed, a perfect mass of *Strophodonta demissa*, and *Rhynchonella congregata*, ... 2'
   (d) very hard bluish gray to yellowish gray sandstone, in layers 4''–12'' thick, the lowest 8' being quite massive, . . 90'
   } 202'
6. Dark olive shales with layers of hard bluish gray sandstone 6''–12'' thick, at intervals of 3–5, ... 100'
7. Dark olive sandy shales weathering into long, slender splinters, ... 25'
8. *Selinsgrove lower sandstone*, hard, gray, in three layers, separated by thin shales, ... 5'
9. Olive brown shales, ... 200'
10. Dark shales and slates often exhibiting *cleavage*, and are much weathered, so that the bedding planes can only occasionally be made out when the dip is about 20°; exposed along the R. R. for 2100' to water tank below Selinsgrove; thickness cannot well be less than . . . . . . 600'
11. *Selinsgrove upper limestone.*
    (a) light gray limestone, impure, with dull fracture, containing *Aulopora tubiformis* and *Ambocœlia umbonata*, . 10,
    (b) drab limy shales, ... 20'
    (c) shaly, impure limestone, with *Coleolus tenuicinctus, Aulopora tubiformis*, . 10'
    } 40'

} 2022' (items 3–11)

12. MARCELLUS SLATE, a series of black, fissile slates with much *pyrite* in basal portion, and occasional *septariae*, some quite large; fossils seen only in upper portion where *Leiorhynchus limitare*, and *Styliola fissurella* were obtained; thickness, ... 300'
13. *Selinsgrove lower limestone*, a hard light gray rock, somewhat impure, in layers 1'–3' thick, interstratified with thin gray shale containing at 15' above base large numbers of *Leptocœlia acutiplicata, Ambocœlia umbonata*, and in less numbers, *Strophomena rhomboidalis, Pleurotomaria* sp? and *Zaphrentis* sp ?; thickness, ... 65'

} 505' (items 12–13)

14. *Selinsgrove shale*, a light gray shale weathering into splinter-shaped pieces, and having a few thin layers of impure limestone at top; no fossil seen, ...	140'	
15. Oriskany sandstone, ...		
Total thickness of HAMILTON SERIES, ...		2,796'

This section speaks for itself in showing the remarkable change that has taken place in the *Hamilton beds* after passing southward from the north side of the Berwick axis; for the series has more than doubled in thickness; and with this enormous increase several new members have been intercalated.

The Selinsgrove Upper sandstone is one of these intercalated beds which here makes its appearance in the middle of the *Hamilton group*, and is so thick and massive as to change entirely the topography; for, instead of a wide level valley, as in the north, it is now found making a high ridge along the strike of this sandstone, which is finely exposed where the N. C. R. R. cuts through, just opposite the town of Selinsgrove, and one mile below Selinsgrove Junction. There is not an inch of this sandstone represented in the beds on Fishing creek; so that it is an entirely new member of the series.

The Selinsgrove Lower sandstone is an unimportant bed here, but further south, near the southern line of Northumberland, it thickens up to 100'.

The Selinsgrove Upper limestone here makes it appearance, at the base of the *Hamilton.*

The *Selinsgrove Lower limestone* here makes it appearance at the base of the *Marcellus.*

This lower limestone seems to occupy the horizon of the *Corniferous limestone;* but its one *Corniferous* fossil, *Leptocoelia acutiplicata*, is more than off-set by the Hamilton form *Ambocoelia umbonata.*

So that taking all the evidence into account, the character of the limestone, &c., the weight of testimony would be in favor of its *Hamilton age* rather than *Corniferous.* It thus seems to represent the *gray Marcellus beds* which in Pike and Monroe are everywhere found 400'–500' thick,

resting on the *Corniferous limestone*, and overlaid by the *black* beds.

Some layers of the *lower limestone* are rather pure, and were once burned into lime on the north side of the Selinsgrove arch, 2½ miles above Silinsgrove Junction. This limestone is finely exposed along the N. C. R. R., just below Selinsgrove station.

The *Selinsgrove shales*, below it, would evidently occupy the *Cauda galli grit* horizon, if the limestone were *Corniferous.*

Third or Southern type.

The southern type of Hamilton beds is reached after passing south from the *Georgetown axis*, near the southern border of Northumberland, there being a progressive coarsening up of the series in that direction from the locality of the last section, near Selinsgrove.

The following section taken along the N. C. R. R. two miles below Georgetown shows a striking change from the Northern and Middle types of Hamilton rocks :

Section two miles below Georgetown (Fig. 17, page 74.)

1. *Selinsgrove Upper sandstone*, visible,	100′
2. Olive brown shales,	300′
3. *Selinsgrove Lower sandstone*, top massive, bottom shaly,	50′
4. MARCELLUS? *Dark shales*,	25′
5. Hard shaly, limy beds, *Selinsgrove Lower limestone*,	75′
6. *Gray shales*, Selinsgrove,	50′
7. ORISKANY SANDSTONE,	
Total,	600′

There are about 600′ between No. 1 and the *Chemung.* Even this addition would only give a thickness of 1200′ here, instead of 2796′ as at Selinsgrove.

Section 17 was taken near the 120th mile-post; then passing south the dip brings the Chemung down to the track; then the dip is reversed and the crest of a low arch is crossed at the 119th mile-post where the succession is as follows :

Section at 119th mile-post, (Fig. 18, page 74)

1. *Chemung beds,*	
2. Concealed,	400′
3. *Selinsgrove Upper sandstone,* yellowish gray, massive,	300′
4. Olive brown shales, lower 50′ somewhat sandy,	325′
5. *Selinsgrove Lower sandstone,* yellowish gray, massive, coarse,	100′

This section properly ties on to the preceding one and shows that the Hamilton beds are only about 1300′ thick here; with deposits totally different from those shown in the sections on Fishing creek and, at Selinsgrove; the *black Marcellus* having disappeared entirely; while there is a great reduction in thickness and corresponding change in character of the other beds; the *Selinsgrove sandstones* becoming more massive.

The *Upper sandstone* makes a long high ridge on either side of the Georgetown arch.

It is difficult to assign any reason for such great changes as the *Hamilton beds* undergo within short distances when one starts across the axes, though in the same trough or along the same arch they preserve a very constant type.

It is possible that the *Marcellus beds* and *lower Hamilton* were largely eroded from the locality of Sec. 17, by the current which carried in the coarse *Selinsgrove sandstones.*

The Cauda galli grit.

It is not certain that there is any representative of the *Cauda galli beds* in this district. But on Big Fishing creek, about two and one half miles above Bloomsburg, there occur some beds down near the base of No. VIII, which so exactly resemble the lithological appearance of the *Cauda galli*, as exhibited in Pike and Monroe counties, that their identity with the latter seems not improbable.

The following section from Big Fishing creek at the locality referred to will show the relation that the supposed *Cauda galli rocks* hold to those above and below:

Section on Big Fishing creek two and one half miles above Bloomsburg (Fig. 19, page 74.)

1. *Chemung beds,*	—
2. *Genesee, Tully,* and *Hamilton* beds,	700′

3.	*Marcellus slate*, mostly black fissile, ...	425'
4.	Gray, hard sandy beds exactly like the CAUDA GALLI in Pike and Monroe counties, ...	25'
5.	Black sandy slate and dark-colored shales, ...	65'
6.	Ashen gray shales with some impure *limestones* at top, .	35'
7.	*Lower Helderberg limestones*, ...	
	Total thickness between Chemung and L. Helderberg,	1250'

If there be any representative of the *Cauda galli* in this section No. 4 is certainly a portion of it, for lithologically no rock could be more like the *Cauda galli* than this.

No. 5 below it may also belong to the *Cauda galli*.

No. 6, however, certainly belongs to the *Stormville shale* horizon; hence No. 5 is possibly a part of the latter.

CHAPTER V.

The Silurian system.

The lowest bed exposed in this region is the top of the *Medina sandstone*, and hence only a portion of the *Upper Silurian* is open to observation and study, viz:

The Oriskany sandstone, No. VII.

The Lower Helderberg limestones, No. VI.

The Salina. } No. V.
The Clinton. }

The Medina, top only seen, No. IV.

The *Niagara* is not distinctly represented.

The area occupied by the *Upper Silurian* beds in Montour county is not large, since only one axis (Berwick) brings up any of them.

In the northern half of Northumberland county several axes elevate the *Upper Silurian rocks* to the surface and spread them over a considerable area, as will be seen by consulting the accompanying geological map.

This is the only rock series within the district that contains any mineral wealth of value; all the *iron ores*, *limestones*, *&c.* that can be profitably mined are found in these rocks.

The different members that make up the *Upper Silurian* will now be described in detail, beginning with the uppermost.

The Oriskany beds, No. VII.

The rocks which constitute the *Oriskany series* were not deposited everywhere over this region, there being no representative whatever of them on Big Fishing creek, as is shown by Sec. 19, page 82.

The Oriskany appears to be completely absent from both sides of the Berwick arch all along its course between Ber-

wick and Bloomsburg; at least not a single outcrop or fragment of the rock was seen between the two localities.

It is true that the horizon of the Oriskany is covered up by the surface dèbris at every locality between Berwick and Bloomsburg, except the one where Sec. 19 was obtained. But if the *Oriskany* existed, some of its *cherty bowlders* would be found on the surface; for, when it does come in west from Fishing creek, its fragments are constantly seen along the line of outcrop, however, deeply the bed rocks may be buried by dèbris.

The most eastern locality at which it has been found in this region is the "Slate quarry" on Little Fishing creek, Columbia county. Near this a quarry in the *Lower Helderberg limestone* reveals 4'–6' of cherty, brown sandy beds filled with *Spirifera arenosa;* overlain by the bluish black beds of the *Marcellus;* and underlaid by a few feet of *Stormville shale*, which rapidly thins out to a knife edge and lets the *Oriskany* down almost in contact with the massive limestones of the *Lower Helderberg.*

On the south side of the Berwick arch the *Oriskany blocks* first make their appearance in the soil just west from Fishing Creek; growing more-abundant as we pass westward toward the Montour county line, at which a tunnel has been driven through the *Oriskany* to reach the *Lower Helderberg limestone.* Here a large amount of *Oriskany rock* has been taken from the Tunnel and now lies on the dump. It consists of cherty, rotten, dirty yellow beds containing some lime, and quite rich in fossils, of which Prof. Claypole has identified the following species:

Spirifera arrecta, *S. submucronata*, *S. arenosa*, *Discina ampla*, *Orthis musculosa*, *Leptocœlia flabellites*, *Rensselaeria ovalis*, *Rhynchonella oblata*, *Platyceras magnificum*, *P. tortuosum*, *Platystoma ventricosum.*

The Oriskany is so *cherty* in Montour county as to resemble almost exactly the *Corniferous limestone* of Pike and Monroe counties. Hence, before a collection of fossils had been made from it, or I had traced it to other portions of the region, it seemed possible that the *Corniferous* might be represented by this *chert*, or *flint bed;* for, at many

localities it is a mere mass of black, impure *chert* in layers 2″–6″ thick. But the cherts were subsequently found passing gradually into the typical *Oriskany sandstone* in other portions of the region, and then the fossils, as given above, show that the bed from which they were taken is genuine *Oriskany;* all being peculiar to the *Oriskany beds* of New York.

The Oriskany chert beds begin to make a low ridge near the western line of Cooper township. This extends from there westward through Mahoning to Danville. The roads crossing this "Hog back" ridge are cut down into the *Oriskany beds* and expose them quite well. One of these at the eastern line of Mahoning gives a clean exposure of the *chert beds* from the base of the *Marcellus* above, down to the *Stormville shale.* The thickness is here 40′.

Limestone ridge in Montour and Northumberland counties is due to the cherty hard Oriskany beds which extend as a broad protecting roof over its southern slope.

In Northumberland county the *Oriskany* is 57′ thick as measured on the north slope of the Selinsgrove arch; is still cherty; has a dirty yellow aspect in the sandy layers; and is filled with its characteristic fossils.

Below Georgetown this stratum is seen above the 20th mile-post along the N. C. R. R., and is there a massive yellowish sandstone, very fossiliferous, but still containing some *chert.*

This rock has been quarried for building stone at only one locality in the district, viz: on the southern slope of Limestone ridge in Liberty township, Montour county.

The Lower Helderberg rocks, No. VI.

The sub-divisions of the *Lower Helderberg limestone* established in Pike and Monroe counties, and described in G⁶, are reproduced with surprising exactness in the counties of this report, more than 100 miles distant. The truth of this statement is shown by the following section, made at the Grove Bro.'s limestone quarry, in Cooper township, at the eastern line of Montour county:

Section at Grove Bro.'s Quarry (*Fig. 20, page 84.*)

1.	*Oriskany sandstone No. VII*,	
2.	*Stormville shale*, a series of blackish and gray shales interstratified with some impure limestones, fossiliferous; containing *Spirifera macropleura*, *Strophomena depressa*, and multitudes of a small flat, branching *fucoid* in some of the black shale beds; thickness,	100'
3.	*Stormville conglomerate*, a very silicious bed, (at times nearly a quartzite,) called "*Sand block*" by the miners; contains some lime and nearly as hard as granite when it was cut by the Grove Bro.'s tunnel; contains *Spirifera arenosa*, or a form very much like it; thickness,	4'
4.	Dark blue limestone, good,	10'
5.	Limy shales, and shaly limestone,	20'
6.	Limestone, blue, good,	3'
7.	Limestone buffish and ochery on its weathered surface, crumbling on exposure,	10'
8.	Limy shales, and shaly limestone,	13'
9.	*Stromatopora bed*, a very hard, tough, bluish-gray limestone, filled with *Stromatopora concentrica*,	10'
10.	Shaly limestone, bluish,	5'
11.	Limestone, dark blue, crystalline, rather pure,	15'
12.	Very massive, somewhat sandy limestone, contains many *crinoidal* fragments,	25'
13.	Bluish, shaly limestone,	12'
14.	*Bastard limestone*, buffish gray, impure, magnesian limestone,	12'
15.	*Bossardville limestone*,	105'
	(a) Dark blue and blackish limestone in thin layers, quite pure, 30'	
	(b) Bluish gray, impure limestone in very thin layers (¼″-1″,) 35'	
	(c) Bluish, and dark gray limestone rather pure; visible, 30'	
	(d) Concealed to top of *Salina*, 10'	

Summary of the section.

Stormville shale, 2,	100'
Stormville conglomerate, 3,	4'
Stormville limestone, 4 to 13,	111'
Stormville cement bed and *Decker's* ferry group, 14 and 15,	24'
Bossardville limestone, 15,	105'
Total,	384'

The following interesting section made at the quarry of Mr. Mauser, in Montour township, Columbia county, exhibits the lower half of the *Lower Helderberg limestone*:

Section at Mauser's quarry (Fig. 21, page 84.)

1. Limestone, shaly and flaggy, bluish, ... 10'
2. *Stromatopora bed*, massive bluish gray limestone, composed almost entirely of *Stromatopora concentrica*, . . 12'
3. Limestone, shaly, bluish, ... 5'
4. Limestone, massive, gray, containing vast quantities of *Holysites catenulata*, ... 20'
5. Limestone, rough, gray, somewhat crystalline; a mere mass of *crinoidal fragments* and broken shells, also containing a form which very much resembles *Cladopora multipora* in large numbers, *Favorites Helderbergiæ*, and many other undetermined forms, ... 12'
6. *Bastard limestone*, a buffish, impure magnesian rock, containing several species of *Beyrichia*, *Strophomena rugosa*, *Atrypa reticularis*, *Rhynchonella formosa*, and other fossils, ... 20'
7. *Bossardville limestone*, a series of thinly bedded, flag-like beds, very dark at top, and filled with *calcite* in thin irregular veins, very pure, for about 35' when more shaly beds intervene, containing vast numbers of *Leperditia alta*, and continue for 35' more where dark blue, purer beds succeed to the base of the series, or top of the *Salina*; entire thickness, ... 120'

Total, ... 199'

The character of these beds in eastern Columbia, south from the *Berwick axis*, is shown by the quarry of Low Bros. & Co., near Lime Ridge:

Section at Low Bros. quarry (Fig. 22, page 84.)

1. Limestone, bluish gray, ... 5'
2. Shaly limestone, and limy shales, ... 10'
3. Limestone, bluish gray, shaly, ... 8'
4. Limy shales, and shaly limestone, ... 5'
5. Limestone, dark, filled with *Leperditia alta*, ... 5'
6. Drab, sandy, limy shale, ... 6'
7. Dark blue, limy shale, ... 6'
   Stromatopora bed absent.
8. Limestone, bluish gray, massive, rather pure, fossiliferous, 35'
9. *Bastard limestone*, ... 20'
10. *Bossardville limestone*, dark blue and bluish black limestone in thin layers, non-fossiliferous, nearly all pure enough for burning into lime; entire thickness down to top of *Salina*, ... 105'

Total, ... 205'

The Stromatopora bed was not noted in the foregoing section, but in another made only a few rods east and directly

opposite Lime Ridge Station, it is seen coming in at the top of No. 8, or 25′ above the "Bastard limestone."

The following analyses made from the beds of this quarry by Mr. McCreath represent the quality of the *Lower Helderberg beds* wherever they are normally developed in the region:

	Carbonate of Lime.	Carbonate of Magnesia.	Oxide of iron and Alumina.	Phosphorus.	Silicious matter.
Specimens from No. 5 of Sec., . .	88.450	4.782	.660	.020	6.260
" " No. 8 " . .	82.371	7.791	1.190	.023	8.830
" " Bastard L. S., . .	70.981	5.630	3.440	.032	19.510
Upper part of Bossardville L. S., .	92.314	3.901	.530	.006	3.340
Middle " " " .	96.125	1.767	.500	.006	1.820
Lower " " " .	94.267	1.934	.550	.020	3.480
" " " " .	93.378	2.004	.630	.014	4.170

On the north side of the *Berwick Axis* the *Lower Helderberg* suffers a considerable reduction both in thickness and quality, as will be seen by the following section from Big Fishing creek, two and a half miles above Bloomsburg:

Section on Big Fishing creek (23, page —.)

1. *Stormville shale*, ash colored shales with limy beds at top,. 35′
2. Limestone, gray, shaly, ... 20′
3. Limestone, sandy, ... 10′
4. Drab, limy shales, ... 30′
5. *Bossardville limestone*, bluish black beds somewhat shaly and flaggy, ... 50′
6. *Salina* beds, ...

Total, ... 145

The Lower Helderberg limestone is so poorly developed on the north side of the Berwick arch that only a half dozen quarries have been opened in it between the eastern line of Columbia county and the meridian of Danville in Montour.

At this latter locality it begins to thicken up again and some valuable quarries have been operated on it between Mahoning creek and the river.

At Russel's quarry, on the north side of Montour ridge near Danville, the following structure is exhibited:

Section at Russel's quarry (Fig. 24, page 84.)

1. ***Stromatopora bed,***	10′
2. **Hard, blue, fossiliferous limestone,**	25′
3. ***Bastard limestone,***	20′
4. ***Bossardville limestone,*** **bluish black in thin layers, non-fossiliferous, becoming bluish-gray toward the base,**	70′
5. ***Salina*** **beds,**	
Total,	125′

On the south slope of the *Milton arch* these beds have the following structure, as revealed in a section made through Limestone Ridge along a small stream at the north line of Liberty township, Montour county:

Section through Limestone ridge (Fig. 25, page 84.)

1. ***Oriskany sandstone, No. VII,***	
2. ***Stormville shales,*** **dark and ashen gray,**	75′
3. **Concealed,**	40′
4. ***Stromatopora bed,*** **massive,**	10′
5. **Limy shales and shaly limestone,**	15′
6. **Limestone, massive, gray fossiliferous,**	25′
7. ***Bastard limestone,***	15′
8. ***Bossardville limestone,*** **dark blue, and blackish in thin layers, 75′ visible, and 25′ more concealed down to top of** ***Salina,***	100′
Total thickness,	280′

Nothing like a detailed section of this limestone could be obtained north of the Milton axis in either Montour or Northumberland counties; but so far as could be ascertained from imperfect exposures at several horizons, the series is not so thick; nor does it contain as much good limestone as it does on the south side of the Milton arch.

When followed southward from the *Berwick axis* the *Lower Heldenberg beds* seem to expand considerably in thickness, presenting the following structure on the south side of the *Selinsgrove axis,* as exposed along the N. C. R. R. north from the 134th mile-post.

Section north of Selinsgrove (Fig. 26, page 84.)

1. ***Oriskany beds, No. VII,***	
2. ***Stormville shale,*** **ashen gray and dark colored beds, containing some cherty layers at top, and limy ones near center; thickness,**	125′

3. *Lower Helderberg* limestone, massive, hard, rather sandy fossiliferous bluish gray,	10′
4. Blue, shaly limestone,	5′
5. Limestone, massive, bluish gray, fossiliferous, containing several layers of *chert* in upper half,	10′
6. Bluish gray impure limestones interstratified with thin limy shales,	98′
7. Massive bluish gray limestone fossiliferous at top, where many specimens of *Strophomena rhomboidalis* are seen,	30′
8. Hard, impure, bluish gray limestones weathering into small rounded fragments, and making a kind of terraced outcrop,	72′
9. Massive, dark blue, and gray limestone, very good,	20′
10. Gray, banded impure limestones exhibiting *columnar structure* (*stylolites*),	30′
11. Shales, limy and concealed,	10′
12. Shaly limestone, and limy shales,	35′
13. Dark blue, limestone, pure,	8′
14. Limy shales;—horizon of *Lead* and *Zinc ores*,	3
15. Limestone, bluish black quite pure,	12′
16. *Salina* beds,	
Total thickness,	468

The series has so thickened up here as to partly obscure some of the horizons so well marked in other parts of the region. But as only Nos. 9, 13, and 15 are pure, it seems probable that the *Bossardville beds* are represented by No. 9–15 inclusive, (here 118′ thick,) while No. 3–8 inclusive would represent the *Stormville* and *Bastard limestones*.

The Stromatopora bed was not observed in this section; but on the north side of the arch, only one mile distant, it is found at 95′ above the top of No. 9, so that it would belong in No. 7 of this section, and was very probably overlooked.

On the north side of the *Georgetown axis*, the *Lower Helderberg* rocks are pretty well exposed at the north line of the township, about 2½ miles east from Georgetown where they exhibit the structure shown below:

Section at Emerich and Lebo's quarry (*Fig. 27, page 84.*)

1. *Oriskany sandstone No. VII*,	
2. *Stormville shale*, ashen gray to dark brown beds, some of them limy, and others cherty,	75′
3. *Stormville conglomerate*. A massive sandy limestone, full of chert,	7′

4.	Shaly limestone, and concealed,	25'
5.	Massive, impure limestone, bluish gray, cherty at top for 5',	20'
6.	Concealed,	40'
7.	*Stromatopora bed,*	10'
8.	Bluish gray limestone, impure,	20'
9.	*Bastard limestone,*	25'
10.	*Bossardville limestone,* bluish black for 25' in thin layers and quite pure, succeeded by bluish gray shaly beds to bottom of exposure,	45'
	Total thickness exposed,	267'

One more section of the *Lower Helderberg beds* will be given to illustrate that series as exhibited on the south side of the Georgetown arch, at the farthest point south that these rocks are exposed within my district. This is from a section taken one mile and a half below Georgetown, along the N. C. R. R. as follows:

Section below Georgetown (Fig. 28, page 84.)

1.	*Oriskany sandstone No. VII,*		
2.	*Stormville shale,* gray and dark with some cherty beds near center,		100'
3.	Limestone, gray, shaly, fossiliferous,		50'
4.	Limestone, massive, bluish gray, fossiliferous,		10'
5.	Impure, buffish, gray limestone,		25'
6.	Bluish gray, massive, impure, fossiliferous limestone,		50'
7.	*Bossardville limestone.*		
	(a) Dark blue pure limestone,	20'	115'
	(b) Bluish gray impure beds,	10'	
	(c) Blue limestone, good,	15'	
	(d) Shaly, bluish gray limestone, impure,	40'	
	(e) Bluish black limestone, quite pure,	30	
8.	*Salina beds.*		
	Total thickness,		350'

A simple inspection of the foregoing sections, and comparison of them with the structure of the *Lower Helderberg series* as worked out by me in Pike and Monroe counties, (Report G⁶,) reveal a remarkable correspondence of the different subdivisions, seeing that the two districts are separated by nearly a hundred miles; for, the following are my subdivisions of the *Lower Helderberg series* in Pike and Monroe counties:

Stormville shale,	150'–160'
Stormville conglomerate,	0'– 25'
Stormville limestone, (enclosing *Stromatopora bed* near the center,	75'–100'

Stormville cement bed,	5'- 10'
Decker's Ferry beds,	30'- 40'
Bossardville limestone,	90'-100'
Total thickness,	350'-435'

I exclude the subdivision of the *Poxono Island beds* because I now know this to be a part of the *Salina group.*

The Stormville shale.

As shown in the previous sections, the *Stormville shale* in this district varies from 35' to 125', but is generally not far from 100' thick. At one locality on Little Fishing creek, about two miles north of Bloomsburg, it is seen thinning rapidly from 15' down to only 2'. This occurs at a limestone quarry just below the "Slate works;" and since the Oriskany cherty sandstone caps the *shale* above, and the massive limestones enclose it below, there can be no mistake about the identification.

As usually developed, this subdivision consists of ashen gray shales, and a considerable thickness of dark brown or nearly black beds, the latter occasionally making up nearly the entire thickness. Interstratified with these are often seen some thin beds of impure, shaly limestone, and occasionally some layers of *chert.*

Fossils are generally present in this shale, though they are seldom abundant. The most common forms are *Spirifera macropleura*, and *Strophomena depressa;* and wherever the *black* or *dark shale* occurs a flat, ribbon-like, branching *Fucoid*, much resembling *Buthotrephis gracilis*, is nearly always imbedded.

The Stormville shale seems to stand to the *Oriskany sandstone* above, and to the *Lower Helderberg limestones* below, in the relation of a *transition series;* connecting Nos. VI and VII, without properly belonging to either. But I have included it with the *Lower Helderberg* because its fossils seem to ally it more closely with that formation than with the Oriskany. When its sediments grow coarse, however, as they do in western Monroe and Carbon counties, it would then be called *Oriskany.*

The Stormville conglomerate.

The very siliceous, calcareous sandrock occurring at the base of the Stormville shale in Sec. 20, comes at the exact stratigraphical horizon which the *Stormville conglomerate* occupies in Pike and Monroe counties.

It was called the "Sand block" in the Grove Bro's. tunnel, and the miners reported it to be *as hard as granite.*

On weathered surfaces where its calcareous matter has been leached out, some of it has the appearance of a coarse porous sandstone; in other portions it looks more like chert, or quartzite. The sandy portions frequently contain a large coarse *Spirifer* which I could not distinguish from *S. arenosa* of the *Oriskany.*

The beds immediately under the *Stormville shale* are often quite sandy. But, only in the vicinity of Grove's quarry, for a mile or two on either side of the Columbia-Montour county line, do they look anything like a sandstone, though in one or two sections sometimes *cherty* and usually massive.

The Stormville limestone.

With the *Stormville limestone* of Pike and Monroe counties, I have correlated all of the limestones which intervene between the base of the *Stormville shale*, and the buffish gray impure bed known everywhere among the quarrymen of Montour and Columbia as the "Bastard limestone."

The thickness of the group when the *Lower Helderberg series* is normally developed varies from 100′-150′, and this may be called the *fossiliferous* portion of the series; for, with the exception of the "Bastard limestone," in none of the underlying limestones were any fossils observed save *Leperditia alta.*

The Stormville limestone is frequently shaly in its upper half and occasionally *cherty* near the top; but when massive is often too impure to burn into lime or use successfully as a flux for iron, except when largely mixed with the purer limestone from the *Bossardville group* below; in fact there are only two or three quarries within the district

where any beds above the *Stromatopora horizon* have ever been quarried for any purpose.

The Stromatopora bed which generally comes near the center of the *Stormville limestone*, has been so designated from the enormous number of *Stromatopora concentrica* which it contains, being in fact simply a *fossil reef* of these sponge-like masses. The bed in which they are so numerous is usually about 10′ feet thick and never more than 15′; being nearly always quite massive and standing out from the quarries as a cliff, in which the *Stromatoporæ* are brought into relief by weathering, and occur in masses of every size from that of a saucer up to two feet in diameter.

This stratum seems unquestionably identical with the *Stromatopora horizon* found near the center of the *Stormville limestone* from the eastern line of Pike county westward into Monroe, and frequently noted in the report of those counties (G⁶). Hence it would appear to be of wide extent and will doubtless be found in many other localities in Pennsylvania when the *Lower Helderberg rocks* are minutely studied.

It is also probably identical with the *Stromatopora beds* in the *Lower Helderberg series* of New York; and should this prove true, it will become a most valuable horizon in the final correlation of the *Lower Helderberg* of New York with that of Pennsylvania.

The Stromatopora bed is usually rather silicious, or at least is seldom pure enough to warrant quarrying for burning into lime or for any other purpose; though, at the Grove Bros. quarry, it is mixed with purer limestone and used as a flux for iron in their furnaces at Danville.

The portion of the *Stormville* limestone below the *Stromatopora bed* often contains some very good limestone; and this is largely quarried in the vicinity of Lime Ridge, as well as everywhere else in Columbia and Montour counties. When followed into Northumberland county, however, this portion of the series becomes quite impure, and is seldom quarried. It is often quite fossiliferous, being especially rich in *crinoidal* fragments and *corals*, including

among the latter the well known species, *Halysites catenulata.*

This fossil has hitherto never been found in rocks that were known to be of *Lower Helderberg age*, and has been considered perfectly characteristic of the *Niagara.* This fossil was seen at only one locality in my district, viz: the locality of Sec. 11, where its relations to the *Stromatopora* and other beds of the series may be seen. It is extremely abundant at this locality, however, and makes up a large portion of the 20′ of beds through which it is found.

The Bastard limestone.

Bastard limestone is a name in use at nearly all the quarries in Columbia and Montour counties to distinguish a light gray, or buffish blue, very tough, impure limestone, which separates the *good limestone* found at the base of the *Stormville beds* from the very pure limestones of the *Bossardville horizon* below.

On account of its position between the two portions of the *Lower Helderberg series* that are most valuable, its presence very often largely increases the cost of quarrying, since it must be broken up and removed as waste, or else (since the *Lower Helderberg* always dips at a high angle) either the upper (Stormville) or lower (Bossardville) beds must be worked out in a long trench before the other can be reached, by cutting through the wall of "Bastard limestone," which then remains as a great overhanging ledge directly through the center of the quarry.

At the Lime Ridge quarries it is broken up and removed entire, some of it being used for building the piers of bridges and for other rough work.

Its thickness is quite variable, sometimes running down to only 10′ to 12′, and again thickening to 25′ or 30′.

Its composition at Lime ridge is given under Section 22, though if anything may be judged from physical appearance it is often much more *magnesian* than that analysis would seem to indicate.

It usually contains *fossils* in considerable numbers, the most common forms being *Atrypa reticularis*, *Strophomena*

rhomboidalis, *Rhynchonella formosa*, and some minute forms which are probably *Beyrichias*.

The Bastard limestone seems to represent the *Stormville cement bed*, as well as the *Decker's Ferry group* of Pike and Monroe counties, (the "Peth rock" of Prof. Cook in the New Jersey section.)

The Bossardville limestone.

The beds of limestone which come next below the *Bastard horizon* of this district answer so perfectly to the color, structure and general character of the beds which were termed the *Bossardville limestone* in Pike and Monroe counties, that there can be no doubt of their identity with the latter, and hence the same name has been applied to the corresponding beds of this district.

Their distinguishing features are—

(1°). They are the only beds constantly pure enough for burning into lime in Pike, Monroe, and Carbon; in Northumberland county no others are wrought. It is only from them that white lime for plastering can be procured. Their purity is also sufficiently indicated by the analysis from Lime Ridge given under Sec. 22, page 90.

(2°). They often occur in thin flaggy layers only 1″–2″ thick.

(3°). The color is usually very dark blue or more frequently a bluish black, appearing darker by contrast with the thin veins and strings of calcite which usually occur in it abundantly.

(4°). The series is almost non-fossiliferous the only form ever seen being *Leperdita alta* which sometimes occurs in the impure portions.

The thickness of the whole mass is usually not far from 100′, sometimes a few feet more, and again a few feet less.

Not all of this is good limestone, however, for there is often a band of impure layers 20′–30′ thick, or even more, near the center.

As this is the limestone formation of the region, *par excellence*, it deserves exploration where concealed.

In Frosty valley, for instance, there are no quarries in

the *Lower Helderberg limestone*, between Buckhorn and Mahoning creek, a distance of 10 miles, the outcrop of the limestone along this line having been buried by surface débris in the old valley that stretches along the northern base of Montour ridge, following the strike of the *L. H. limestone* and *Salina beds.*

It can hardly be possible that the *Bossardville limestone* is absent along this entire distance, since it goes under the trash with a good thickness just east from Buckhorn, at Little Fishing creek, and comes out again as a valuable bed at Mahoning creek, as shown in Sec. 24, page 91.

The same statement applies to the region south of Montour Ridge; for, wherever this limestone seems to be absent, its outcrop is simply covered up by an uncertain thickness of surface trash. It could certainly be found anywhere between Berwick and the river above Northumberland by a systematic search along its line of outcrop as colored on the accompanying geological map.

At many localities it is doubtless buried to so great a depth by the surface trash that it would be impracticable to quarry it; but there are many others where it could be uncovered and profitably mined; and this is especially true of the region lying just east from Danville, where no trace of the *Lower Helderberg* is seen for about three miles. It is undoubtedly there; and proximity to the Danville furnaces should encourage a systematic search for it. Its top appears in the bed of the river at the south end of the bridge leading to South Danville, and a line running about N. 80° E. from that point will pass near its uppermost beds for several miles.

Lead and Zinc ores.

Lead and zinc have been found in considerable quantity just above the base of the *Bossardville limestone*, (as indicated in Sec. 26, pages 91, 92,) along the river between Sunbury and Selinsgrove Junction, in Northumberland county.

The mine is reported to have first been discovered about 40 years ago, and some of the ores shipped east in barrels on the Pennsylvania canal; but as the results were kept

secret, no one pursued the matter any further until the past year, (1882,) when Mr. Doughty of Shamokin undertook a systematic development of the ore.

The mine now being developed comes at the very crest of the *Selinsgrove arch*, near the 135th mile-post on the N. C. R. R., and the ore occurs about 10′ above the base of the *Bossardville limestone.* It occurs in "stings" and "pots," mixed with a large amount of muddy rubbish much resembling the deposits from a stream of turbid water flowing among rocks.

The course of the deposit appears to run with the strike of the beds, which is here nearly east and west; though the ore has not been followed into the hill far enough to determine much about its extent or manner of deposition.

Several tons of ore lay on the dump when I visited the mine, and from pieces selected at random Mr. McCreath made the following analysis:

Metallic lead,	24.191
Metallic zinc,	31.954
Metallic copper,	1.389

Both the lead and zinc occur chiefly as sulphides, while the copper is in the form of carbonate.

From this analysis it is plain that Mr. Doughty will have a valuable mine if he can find the ore in sufficient *quantity.*

This same horizon has furnished indications of *Lead* and *Zinc ores* about half way between Lime Ridge and Espy, in Columbia county, where a drift was once run into the hill, near the line between Scott and Center townships. It is reported that masses of *Galena* more than a foot in diameter were taken from the rocks at this locality; but it seems that the ore was not found in quantity sufficient to warrant mining; though, since the developments at Mr. Doughty's mine, an effort is being made by some parties to re-open the Espy mine.

Although I could neither make a systematic collection nor a thorough study of the Lower Helderberg fossils, in the time at my command, the following is a pretty complete list of those which I observed at the different quarries.

Prof. Claypole, who is specially engaged on this part of the work, will in time supply the deficiency.

Atrypa reticularis, from the Bastard limestone upward.
Strophomena depressa, " " "
S. rhomboidalis var. rugosa, " " "
Rhynchonella formosa, " " "
" *ventricosa*, " " "
Spirifera macropleura, Stormville shale only.
Tentaculites gyracanthus, a single specimen from upper half of *Stormville limestone*.
Orthoceras longicameratum? upper half of Stormville L. S.
Halysites catenulata, lower half of Stormville L. S.
Favosites Helderbergia, " " " "
Stromatopora concentrica, middle and half of Stormville L.S.
Cladopora multipora? lower half of Stormville L. S.
Beyrichia, two or three species, throughout the series.
Leperditia alta, two or three species, throughout the series.
Zaphrentis sp? from Bastard limestone upward.
Ambocoelia biconvexa n. sp. Claypole, from Bastard limestone to Oriskany.

Many others occur in a fragmentary condition and were thus not identified, while doubtless many more escaped the limited search made for fossils in the *Lower Helderberg beds.*

The Salina series.

The pure limestones of the *Bossardville group* are everywhere abruptly terminated below by a succession of buffish-gray, pale green, magnesian, and otherwise impure limestones which have generally been considered a part of the *Lower Helderberg series;* but, as they are succeeded by other beds which characterize the *Salina series* in New York, I have deemed it best to cut them off from the *Lower Helderberg beds.*

There is only one locality in the district where the exposures are complete, or nearly so, between the *Lower Helderberg rocks* and the *Clinton.* The beds at this horizon all decompose readily, and are nearly always buried by trash in the valleys that occur along their strike. Fishing

creek, however, cuts squarely across the *Salina valley;* and its western shore washes against the steeply dipping *Salina beds*, along which a new road has lately been constructed between Bloomsburg and Light Street village. In the almost continuous rock cuts of this road, beginning 2½ miles above Bloomsburg the following section of the *Salina beds* was observed (continuation of Section 23):

Section along Big Fishing Creek (Fig. 29, page 102).

Upper Salina group.

1.	Pale buff and greenish magnesian limestone, quite impure,	75'	
2.	Shales, limy, pale green,	10'	
3.	Limestone, impure, pale green,	10'	
4.	Concealed,	5'	
5.	Limestone, and limy shales,	10'	
6.	Concealed	8'	
7.	Buffish shaly limestone,	15'	
8.	Pale green, magnesian limestone,	15'	
9.	Bluish gray limestone, impure,	5'	
10.	Buffish, limy shales,	10'	
11.	Blue, shaly limestone,	10'	
12.	Buff and greenish shales,	18'	
13.	Bluish gray, impure limestone,	4'	
14.	Pale green, limy shales,	15'	
15.	Bluish gray limestone, rather pure,	2'	
16.	Buffish, limy shales,	2'	
17.	Pale green, shaly limestone, and limy shales,	55'	
18.	Buffish, magnesian limestone,	15'	
19.	Blue, shaly limestone,	5'	
20.	Greenish, limy shales,	40'	
			329'

Middle Salina group.

21.	Pale green, limy shale with *purplish* cast,	7'
22.	*Red shale*, containing 10–12 per cent. of iron,	5'
23.	Shales, limy, pale green,	30'
24.	Buff, and bluish, magnesian limestone,	5'
25.	Pale green, limy shales,	25'
26.	Concealed,	15'
27.	Bluish, limy shales,	10'
28.	Greenish, limy shales,	35'
29.	*Red shale,*	5'
30.	Concealed,	5'
31.	Greenish gray, sandy shales,	15'
32.	Pale green shales,	30'
33.	Concealed,	40'
34.	Green shales,	10'

35.	*Red shale,*	5'	
36.	Concealed,	5'	
37.	Green shale,	5'	
38.	*Red shale,*	5'	
39.	Varigated shale, (red and green,)	5'	
40.	Limestone, bluish gray, good,	3'	
41.	Green shale,	10'	
42.	*Red shale,*	10'	
43.	Green shale,	20'	
44.	Limy shale,	5'	
45.	Limestone, gray, rather pure,	4'	
46.	Green shale,	3'	
47.	*Red shale,*	20'	
48.	Limestone, gray, impure,	5'	
49.	Concealed,	5'	
50.	Green shale,	5'	
51.	Concealed,	20'	
52.	*Red shale,*	5'	
53.	Greenish shales, containing thin, bluish gray, impure limestones,	20'	
54.	Green shale,	10'	
			407'

Lower Salina group.

55.	***Bloomsburg red shale,*** a series of dark red shales, somewhat sandy, and blotched with a few thin layers of bright green, visible in the vicinity of Bloomsburg, about	440'
56.	***Clinton beds,***	——
	Total thickness of SALINA *series,*	1176'

From this section it will be seen that the *Salina beds* of this district may be subdivided into three very well defined groups, viz: *Upper*, *Middle*, and *Lower*.

The upper Salina group.

By the above name has been designated that succession of buffish, pale green limestones, and limy shales which everywhere in the district make their appearance immediately beneath the Bossardville beds at the base of the *Lower Helderberg.*

The base of this group is placed at the *lowest red bed,* and as thus limited the *Upper Salina beds* have a thickness of 329' in the section above given; and probably is not less than this anywhere in the region, though this is only an inference from the breadth of outcrop usually found between the base of the *Lower Helderberg* and the *first red*

beds below; for, as already stated, the locality of Section 29 is the only place in the region where the detailed structure can be studied and the thickness accurately measured; though the upper half is quite well exposed at Russell's quarry, one mile and a half north from Danville, in Montour county, where the following succession was observed (continuation of Section 24):

Section at Russell's quarry, (Fig. 30, page 102.)

1.	*Bossardville limestone*, base of Lower Helderberg.	
2.	Bluish green, impure limestones containing small, irregular cavities lined with crystals of calcite,	10′
3.	Limy shales,	5′
4.	Hard, bluish gray, magnesian limestones,	20′
5.	Drab limy shales,	8′
6.	Limestone, blue and shaly,	10′
7.	Buffish, and greenish gray, limy shales,	45′
8.	Bluish limestone, banded with thin blue and gray layers,	7′
9.	Limy shales, gray and greenish,	10′
10.	Bluish gray limestone, once quarried, not very impure,	20′
11.	Buffish limy shales,	10′
12.	Concealed,	20′
13.	Pale green, buffish, and bluish limestones to bottom of exposure,	25′
	Total of *Upper Salina* visible,	185′

The cavities occurring in No. 2 recall the upper portion of the *Salina beds* in New York, although here the lining material is different.

Gypsum was not seen in these *Upper Salina beds*, yet it most probably exists in small disseminated particles, since the 329′ of rock on Fishing creek are locally called "Sulphur stone," from the fact that in an attempt once made to burn them into lime, they gave off an intolerable odor of sulphur.

The hopper shaped cavities, vermicular markings and other peculiar features of the *Upper Salina* in New York were not observed anywhere in this district; but the general stratigraphical relations of the group, its barreness of organic remains, its color and other physical aspects, seem to point unmistakably to its equivalency with the upper portion of the *Salina* of New York.

Not a single fossil was observed in the Upper Salina rocks anywhere within the district.

Some of the beds are occasionally pure enough for burning lime; but at only one locality have they been quarried, viz: Russell's quarry near Danville, where No. 10 of the last section was once mixed largely with the purer *Bossardville limestone*, and used as a flux in one of the Danville Iron furnaces.

An attempt was once made to open a limestone quarry on these beds half way between Lime Ridge and Espy, but no layers pure enough for burning were found.

The middle Salina group.

The above name has been used to designate that portion of the *Salina* which consists of *alternating red and greenish shales*, *limestones*, &c., which also comes near the middle of the formation and in Sec. 29 has a thickness of 407'.

Its character is sufficiently described in the detailed section given above from Nos. 21-54, the study of which will readily convince any geologist that the group harmonizes perfectly with the second member of the New York *Salina*, or the *Variegated group* which comes in above the *red shale* basal member of the *Salina* in New York.

Some of the limestones in the lower half of the *Middle member* are rather pure, though so far as I could discover none of them have ever been quarried within the district. The purer beds are blue, or bluish gray, but non-fossiliferous.

The lower Salina group.

Bloomsburg red shale is the name which I have given to the thick mass of *red rocks* which constitute the *Lower Salina beds* of this district, and which are so well exposed along the east bank of Fishing creek in the cuts of the Bloomsburg Iron Co.'s R. R. at the north line of the town of Bloomsburg.

Very nearly the full thickness is seen at this locality; but the green shales at the base of the *Middle Salina* are not quite exposed in the 440' of beds measured there; and hence the entire thickness is possibly 10'-20' more; though, from

the fact that a few thin laminæ of buffish calcareous material come in the uppermost portion visible, the thickness cannot well be much greater than that given.

There is no locality within the district, however, where a complete exposure can be found; and hence the exact thickness is uncertain, but it cannot be more than 500′, and probably 450′ is nearer the correct figure.

The Bloomsburg red shale is usually rather sandy, and often stands up in steep bluffs and cliffs, especially where it is cut by streams; the color is generally a very deep or dull red, though occasionally some of the beds are rather bright; and, where well exposed to atmospheric action, some thin layers of *apple green* shale are always interlaminated with the *red beds*. Often for several feet no lamination whatever appears, but the whole mass weathers away by breaking across the bedding into small, irregular chips, which give the cliffs a peculiar roughened aspect.

A *Lingula*, poorly preserved and of an unrecognized species, is the only fossil I have seen in the entire group. It was seen near Chulosky furnace, on the D.L. & W.R.R. near the eastern line of Northumberland county, where the succession is as follows:

Section near Chulosky Furnace, (Fig. 31, page 102.)

1. *Red shale*, blotched with green,	60′
2. Variegated (red and green) shale containing *Lingula sp?* in large numbers,	1′
3. *Red shales*, containing a few thin streaks of green,	300′
4. Greenish, limy shales,	5′
5. *Red shale*,	30′
6. Green shale,	5′
7. *Red shale*,	15′
8. *Clinton beds.*	——
Total thickness of *Lower Salina group*,	416′

This section, like the one at Bloomsburg, does not quite reach the top of the group; but in the concealed interval above No. 1 some green shale was observed about 25′ higher, which cannot be far from the top; this would give a thickness of 441′.

Below No. 7, we get 20′ of bluish green shale, and then another *red bed* 4′ thick, so that if these be included in the

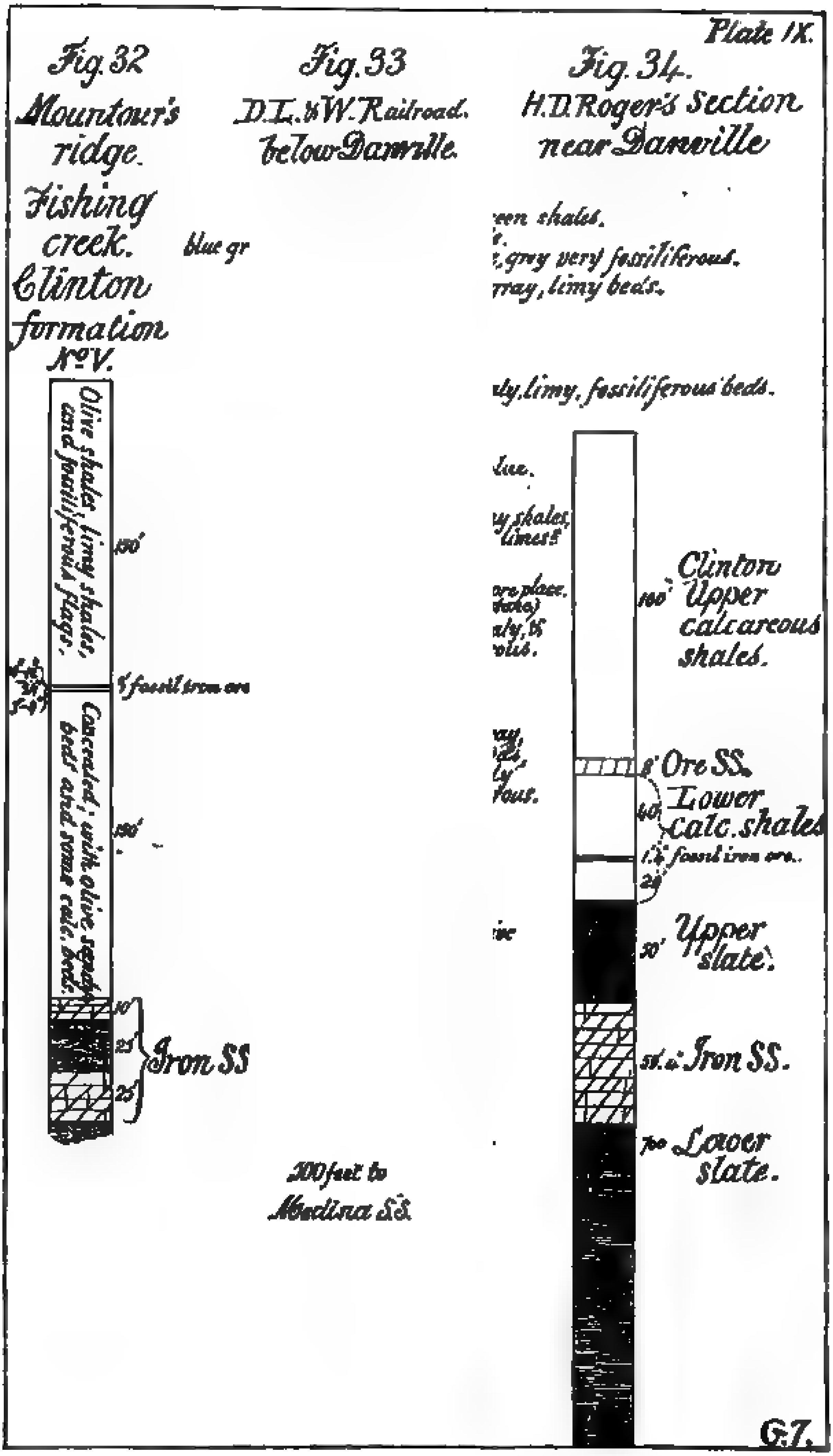


Plate IX.
Fig. 32
Mountour's ridge.
Fishing creek.
Clinton formation
No. V.
Olive shales, limy shales, and fossiliferous flags.
150'
fossil iron ore
Concealed; with olive sandy beds and some calc. beds.
150'
10'
25
25
Iron SS
Fig. 33
D.L.&W. Railroad.
below Danville.
200 feet to
Medina SS.
Fig. 34.
H.D. Roger's Section
near Danville
160'
Clinton
Upper
calcareous
shales.
8' Ore SS.
40
Lower
calc. shales
1½' fossil iron ore.
24'
50'
Upper
slate.
Iron SS.
700
Lower
slate.
G.T.

Salina the *Bloomsburg red shale* would have a thickness of 465′ at Chulosky. But as this lowest red bed is thin, I have placed it in the *Clinton* in the section made there; although it and the 20′ of bluish-green above is are really *transition beds* belonging as much to the *Salina* as to the *Clinton.*

There can be no doubt whatever that the *Bloomsburg red shale* represents the basal member of the *Salina series* as defined by the New York geologists; for not only does its stratigraphical position fit in exactly with the great *red bed* at the base of the *Salina* in New York, but even the physical peculiarities of the latter are completely reproduced.

The Salina rocks, as a whole, like the *Hamilton*, make valleys along their line of strike.

This is finely shown in the continuous valley on either side of Montour ridge from the eastern line of Columbia county on westward to the West Susquehanna river.

The *Salina beds* are confined entirely to two long narrow valleys just alluded to, and to a rather broad triangular-shaped area which, beginning just north from the *Milton axis* at the western line of Montour county, rapidly widens westward, covering Turbut and the southern portions of Lewis and Delaware townships of Northumberland county.

The Selinsgrove and *Georgetown axis* only succeed in bringing up the very top of the *Salina* where they enter the district across the Susquehanna river.

The soil made by these beds, especially the Upper and Middle groups, is the most fertile in the district; the topography is always gentle, and a large quantity of lime, as well as other elements of fertility, are set free when the rocks decompose.

The Poxono shales and limestones of Pike and Monroe counties, which were provisionally assigned to the *Lower Helderberg* in G^6, represent the *Upper and Middle Salina beds* of this district.

The *red shale* which immediately underlies them, and was erroneously referred to the *Clinton beds* in G^6, is identical with the *Bloomsburg red shale* or *Lower Salina* of this region. Since it is exposed only at its top in Pike and

Monroe counties, nothing definite can be known concerning its thickness; for a part of the concealed interval along the valleys in which it is found there may really be *Clinton*, though it is very probable that no rocks of the latter age exist in Pike and Monroe, the lowest member of the *Salina* having been deposited on the sandstones and *red beds* of *No. IV.*

The Clinton Series, No. V.

The Niagara formation has not been separated from the *Clinton* in this district, though it is possible that a minute study of the fossil remains which abound in the 150′ of limy beds above the *Clinton fossil ore*, might result in the discovery of a *Niagara horizon.*

The Clinton beds make but a single belt across the western portion of the district, being thrown into a great arch along the line of the *Berwick axis.*

The top of this series first appears on the surface near the eastern line of Scott township, Columbia county; westward from which, as the *Berwick arch* grows higher, the hard *Iron sandstones* come to the surface and make a prominent mountain which, under the name of Montour ridge, extends to the West Susquehanna river.

Section through Montour (Fig. 32, page 108.)

1. *Salina, Bloomsburg red shale,*		—
2. Olive brown shales, limy beds, and flaggy sandstones fossiliferous,		150′
3. *Fossil iron ore,*	*Ore,* "big vein," 10″ to 12″	3′
	Limy and sandy shale, 2′ 0″	
	Ore, "little vein," 8″ to 4″	
4. Concealed and olive sandy beds together with some calcareous bands,		150′
5. *Iron sandstone,*		—
(*a.*) Very hard dark red or reddish-brown sandstone containing 10–15 per cent. of iron,	10′	60′
(*b.*) Shales, yellowish-green with streaks of red,	25′	
(*c.*) Dark brown sandstone containing thin streaks of lean *iron ore* and some shales,	25′	
6. Pale yellowish-green and olive shales to crest of Berwick axis, in the gap of Fishing creek,		350′
Total thickness of CLINTON No. V exposed,		713′

About two miles below Danville near the line between Montour and Northumberland, the following section of the *Clinton beds* was obtained along the D. L. & W. R. R.:

Section below Danville (Fig. 33, page 108.)

1.	*Salina, Bloomsburg red shale,*	—
2.	Bluish-green shales,	20'
3.	*Red shale,*	4'
4.	Bluish-gray shales,	7'
5.	*Limestone* gray, very fossiliferous,	1'
6.	Bluish-gray limy beds,	25'
7.	Concealed,	5'
8.	Bluish, shaly limy beds fossiliferous,	70'
9.	*Limestone,* hard blue,	5'
10.	Limy, gray shales and thin limestones,	55'
11.	*Limestone,* very fossiliferous, (FOSSIL ORE HORIZON,)	1'
12.	Blue, shaly limestone, fossiliferous,	30'
13.	Bluish-gray, limy beds sparingly fossiliferous,	100'
14.	Concealed, and olive shales,	100
15.	*Iron sandstone,* visible,	30'
16.	Olive shales, not well exposed fossiliferous near middle estimated at	500'
17.	*Medina sandstone No. IV,*	——
	Total thickness of CLINTON No. V,	953

It is possible that the thickness of No. 16 in the last section is estimated at too low a figure, but the entire thickness of the *Clinton series* cannot be far from 1000'.

The section of the *Clinton rocks* made in the vicinity of Danville by the 1st Géol. Survey, and published in Geology of Pennsylvania, H. D. Rogers, 1858, Vol. I, pp. 435–6, is as follows:

Section near Danville, (Rogers) (Fig. 34, page 108.)

1.	*Surgent red shale, (Bloomsburg,)*	
2.	*Upper calcareous shales,* sandy argillaceous, green fissile slates, often highly fossiliferous, alternating with layers of fossiliferous limestone 1''–12'' thick,	160'
3.	*Ore sandstone,* a tough calcareous sandstone alternating with thin bands of shale,	8'
4.	*Lower calcareous shales,* green fissile slate with thin plates of limestone, and eight or nine thicker limestone bands, all fossiliferous,	40'
5.	*Fossil ore,*	1' 4''
6.	The same as No. 4,	20'
7.	*Upper slate,* green fissile slate with thin plates of argillaceous sandstone,	50'

8.	*Iron sandstone*, with its *ferruginous* band, ...	59' 4"
9.	*Lower slate*, green slate, weathering yellow, generally sandy, often compact, not fissile, *its iron ore* lying about midway in the mass; *Buthotrephis gracilis* throughout,	700'
	Total thickness of CLINTON, (H. D. Rogers,)	1038' 8"

The foregoing sections are given to show the general structure of the series at the only two localities in the district where any good exposures can be found.

The fossil iron ore given in sec. 32 as coming 150' below the top of the Clinton, has long been extensively mined in the vicinity of Bloomsburg, on both sides of Montour ridge, and is still the main source of supply for the furnaces of the Bloomsburg Iron Co., and Wm. Neal & Sons.

The same ore has also been extensively mined westward from Bloomsburg, to supply the Danville furnaces.

The iron made from this ore is in high repute and has long been greatly valued for the manufacture of car wheels.

Near the surface the ore usually occurs as a loose mud-like deposit, and is then called *soft ore.* When followed further below the surface, the *soft ore* gradually changes to a compact limy rock filled with fossils and containing much carbonate of lime, and is then known as "*hard*" or "*block ore.*" If the beds be followed still deeper the ore gradually grows poorer, in fact, an ordinary limestone, containing 10–15 per cent of iron.

The most of the *ore* from the *fossiliferous* horizon has been taken out in the vicinity of Bloomsburg, except what may be mined from deep workings.

Two specimens of the *fossil ore* from the Bloomsburg Iron Co.'s mine on Fishing creek, analyzed by Mr. McCreath, gave the following results:

Bloomsburg fossil ore.	*No. 1.*	*No. 2.*
Metallic Iron,	17.900	33.700
Sulphur,	.002	.009
Phosphorus,	.267	.407
Carbonate of lime,	64.053	41.160
Carbonate of Magnesia,	5.516	4.116
Silicious matter,	1.520	2.950

The ore bed as shown in the section from Bloomsburg is

usually separated into two (Big and Little) beds by 2′–3′ of hard limy shale, or sandy limestone. In the separating rock as well as in the iron-bearing beds themselves the following species of fossils were identified by Prof. Claypole from specimens obtained at the Bloomsburg Iron Co.'s mine, on the west branch of Fishing creek: *Avicula leptonata*, *Strophomena depressa*, *S. alternata*, *Atrypa reticularis*, *Rhynchonella robusta*, *R. neglecta*, *Beyrichia lata* and *Calymene clintoni*.

This list could undoubtedly be largely increased by a more systematic collection.

The Iron sandstone does not seem to contain any valuable ores in the vicinity of Bloomsburg, east from Fishing creek. West from Bloomsburg, in the vicinity of Danville, however, this ore becomes quite valuable, and has long been extensively mined.

The Iron sandstone is a dark, reddish brown, very compact, hard sandstone, and has been quarried on either side of Montour ridge just above Bloomsburg, and also on the summit of the same near the western line of Scott township. It is excessively hard and almost indestructible by atmospheric influences.

This rock makes the summit of Montour ridge from the western line of Scott township westward to the Montour county line, beyond which the *lower olive beds* cover the rest of the mountain westward to the Susquehanna river (West Branch.)

These *lower slates* have generally a dusky color, but on weathering frequently take on a greenish yellow cast. They seem to grow more sandy and compact toward the west; for a very hard olive-gray sandstone is often found along the southern slope of Montour ridge in great heaps of small angular bowlders which evidently belong to this horizon.

By reference to the sections of the Clinton given from Bloomsburg and Danville, it will be seen that the series can be sub-divided into the following groups:

Upper olive sandy and limy beds, ...	150′	to	200′
Fossil iron ore.			
Middle olive sandy and limy beds, ...	150′	"	200′

Iron sandstone with its included iron ore,	60'	"	60'
Lower olive shales and slates,	500'	"	700'
Total thickness of CLINTON No. V,	860'	"	1160'

The mean (1010') of these two numbers cannot be far from the true thickness of the *Clinton beds* of this district.

The Medina Sandstone, No. IV.

As already stated the top only of the *Medina sandstone* is exposed to view in this region.

This occurs about two miles below Danville, where the Susquehanna river, veering northward, cuts a great hole from the southern face of Montour ridge, stripping off all of the *Clinton beds* and revealing a small area of the *Medina sandstone* (which here forms the core of the ridge,) as a very massive, grayish-white conglomerate mottled with red, of which only 25' are exposed.

CHAPTER VI.

Township geology of Wyoming county.

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1. Braintrem township.

This is a narrow, irregular strip of territory lying between the Susquehanna river and the county of that name, in the extreme north-western corner of Wyoming.

The hills rise abruptly from the Susquehanna river and are everywhere composed of *Catskill rocks*; but the channel of that stream from Skinner's Eddy north-westward to the county line is worn down to the top of the *Chemung beds.*

Flagstone and building stone are the only things of value to be found among the rocks of this township.

The largest quarry is on Tuscarora creek, a short distance above Skinner's Eddy, and is operated by Messrs. Fordyce, Kempler & Co., who ship large quantities of stone to New York and neighboring cities for lintels, stepping-stones, &c.

The following succession was obtained in descending from the quarry to the Susquehanna river:

Tuscarora Creek section (*Fig. 35, page 116.*)

1. Drift,	10′
2. Sandstone, gray,	5′
3. Shales, sandy, olive,	10′
4. Sandstone, bluish-gray, (QUARRY,)	12′
5. Concealed,	30′
6. *Limestone,* blue, silicious, *fossiliferous,*	5′
7. Sandstone, flaggy and shaly, bluish,	30′
8. Concealed to low water in the Susquehanna river, (635′ A.T.,)	20′
Total,	122′

The quarry stone (No. 4 of the section) is a fine-grained sandstone, in layers 4″–12″ thick along the outcrop; but many of the division planes disappear when followed into the hill.

The limestone No. 5 is a solid mass of coarse, distorted

Fig. 36.
Skinners Eddy 1.

Fig. 37.
Skinners Eddy 2

Fig. 38.
Overfield

Delaware Flag Series. Catskill. IX.

ne Quarries.

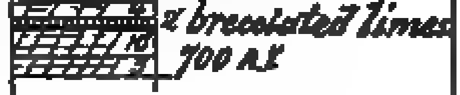
(F 39. below)

n

Fig. 35
Tuscarora Cr.

Fig 39.
Winne & Burk

Catskill IX.



Spirifers, of the general aspect and form of *S. disjuncta*, but possibly very different from it. This limestone is very probably identical with the one which in Susquehanna, Bradford, and Tioga counties so frequently occurs near the top of the *Chemung*.

The dip of the rocks is southward, at the rate of 50′–75′ to the mile; so that, in passing down the river from the locality of the last section the limestone soon reaches R. R. level, and then sinks below the bed of the Susquehanna. It is last seen about one third mile below Skinner's Eddy, where a *flag quarry* is operated on the land of Mr. Kinney. There, a bed filled with *Spirifers* and *plant fragments*, 30′ above the Susquehanna, seems to represent the *Skinner's Eddy limestone.*

The flags obtained at this quarry are 3″–5″ thick, of a bluish-green color, and of very fair quality.

Just above the locality of this quarry, the following succession was observed in descending the cliffs which border the river:

Skinner's Eddy Section (*Fig. 36*, *page 116.*)

1. Sandstone, coarse, visible,	10′
2. Sandstone, flaggy, greenish-gray,	90′
3. *Brecciated limestone*,	2′
4. Sandstone, greenish-gray, flaggy,	75′
5. Shales, green, sandy,	25′
6. Sandstone, flaggy, quarried,	20′
7. Shaly sandstone and concealed,	20′
8. *Red bed*,	25′
9. Concealed and flaggy sandstone,	40′
10. Concealed to R. R. level (655′ A. T.),	30′
11. Concealed to level of Susq. river,	20′
	357′

The rocks of this section stand up in an almost vertical cliff, which rises to nearly 400′ above the river just below Skinner's Eddy.

These sand rocks represent the lower portion of the *Delaware flag series* of Pike and Monroe counties.

A short distance below the last locality the following succession was observed beginning 40′ below the top of No. 6 of the previous section:

Skinner's Eddy Short Section (*Fig. 37, page 116*).

1.	***Red, sandy shales,***	10'
2.	**Green, sandy shales,**	15'
3.	***Red shales,***	15'
4.	**Sandstone, flaggy, to R. R. level,**	50'
5.	***Skinner's Eddy Limestone,*** **visible,**	2'
		92'

No. 5 is more sandy here than in the Tuscarora creek section ½ mile above, but from the profusion of *Spirifers* found in it, the two beds would seem to be identical.

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2. *Meshoppen township.*

This township lies directly east from Braintrem and, like it, borders the Susquehanna river on the south and Susquehanna county on the north.

The west branch of Meshoppen creek enters it from Susquehanna county, and flows southward along its eastern margin for some distance, until, meeting the main stream from the east, the united waters veer west with many windings to the Susquehanna river at Meshoppen. The other streams are all quite small, and rise on the highland from one to three miles back from the river.

The rocks of this township belong principally to the horizon of the *Lower Catskill*, the *Chemung beds* having dipped below drainage level.

Extensive stone quarries have been opened in these rocks, large quantities of building and ornamental stone being shipped from Black Walnut and Meshoppen stations on the Lehigh Valley railroad.

The Wyoming Stone Company has a large quarry about ⅛ mile north from Black Walnut station, and 90' above the level (649' A. T.) of the same. The quarry rock is a bluish-gray sandstone with a slight tinge of green of rather fine grain, and is 50' thick. The various courses of the rock furnish heavy building stone, steps, sills, flags, &c.

A fish and plant bed of brecciated limestone occurs 10' above the base of the quarry rock and about 740' A. T.

Two miles below Black Walnut another large quarry is operated on the land of Mr. Overfield, where the following succession occurs:

Overfield quarry Section (*Fig. 38, page 116.*)

1.	Quarry Sandstone,	30′
2.	*Red sandy shale*,	40′
3.	Sandstone, greenish-gray to R. R. level, (645′ A. T.,)	85′
4.	Concealed to level of Susquehanna river,	30′
		185′

No. 1, the rock quarried here, comes about 100′ higher up in the series than the *Black Walnut stone.* It is a greenish-gray sandrock, furnishing fine large flags as well as heavier building stone.

Archæopteris hybernica occurs in the middle portion of No. 2, in a somewhat macerated condition.

The great quarries of Brownscomb & King are situated on Little Meshoppen creek, ½ mile north from the village of Meshoppen. The base of the quarry rock comes at 725′ A. T. or 80′ above the level of Meshoppen station, and is a rather massive bluish-gray, fine-grained sandstone 45′ thick, in courses of ½′–4′, separated by thin, bluish shales. The best stone is obtained near the base of the stratum, and is sawed and polished into all manner of ornamental work in the company's cutting mills at Meshoppen. Being of fine and even grain, it takes a very smooth polish and is almost perfectly weather-proof.

A bed of brecciated limestone, 5′ thick, occurs at 750′ A. T, and is irregularly stratified with the other material of the rock.

Fine specimens of Archæopteris hybernica, and another form of *Archæopteris*, apparently new, occur in the shales between the courses of stone at this quarry, and many *stems* and *broken fragments* are scattered through the coarser portions of the sandstone.

Winne & Burk have a *quarry* at a lower level a few rods south from that of Brownscomb & King, where the following succession was observed:

Section at Winne & Burk's Quarry, (39.)

1.	Gray sandstone,	4'
2.	*Brecciated limestone,*	2'
3.	Quarry Sandstone, greenish, flaggy,	10'
4.	Quarry Sandstone, greenish gray, (base 700' A. T.,)	5'
		21'

Some flags are obtained from No. 3, but the building stone comes from No. 4.

Glacial striæ, going S. 30° W., were observed a few rods north from the R. R. station in Meshoppen, on a hard green sandstone upon which rest 20' of Drift.

At Meshoppen, the Susquehanna river completes a great curve, and thereafter flows nearly due south for two miles. The rocks dip down quite rapidly in that direction, nearly 250' to the mile, so that a *red bed* seen 40' above the R. R. track at Meshoppen, very soon passes below the same.

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3. Washington township.

This area lies next east from Meshoppen township, having for its northern and southern boundaries, respectively Susquehanna county, and the Susquehanna river. The east and west branches of Meshoppen creek flow across its northern portion, while several small streams drain the southern half directly into the Susquehanna.

This latter stream makes a horse shoe bend, (known as "the Neck,") around the southern end of the township, where after flowing west of south, it sweeps around northward to Vosburg station, making a circuit of 5 miles, while it is only two thirds of a mile across the same at the narrowest portion of "the Neck" near Vosburg.

The rocks of this township belong to the *Catskill* and to the *Catskill-Chemung beds.*

No quarries of any importance have been opened in this township though it is not for want of stone, for very fine flagging could be obtained at almost any horizon.

In passing southward along the river from Meshoppen toward Mehoopany station, the rocks dip considerably, but

at Mehoopany the dip seems to flatten out almost completely, or is even slightly reversed to the north-west. This is due to the presence of the *Bernice syncline* which crosses the Susquehanna river near Mehoopany station, and passes north-eastward through the township as a shallow trough, rapidly dying away to the north-east.

Glacial striæ going S. 28° W. S. 30° W. and S. 32° W., on green sandstone, and *red shales* at an elevation of 1065′ A. T. were noted along the road near Mr. Geo. Luce's.

Barometric elevations in Washington.

Forks of road just north of Mrs. Vosburg's,	725′
" at J. Remington's,	1020′
" at H. Culver's,	1065′
" at Mrs. Russell's,	1100′

4. Tunkhannock township.

This township adjoins Washington on the east, has Lemon for its northern boundary, and the Susquehanna river for its southern. It is drained entirely by Tunkhannock creek, which flows through it in a south-westward direction, emptying into the Susq. river at Tunkhannock, the county seat.

A great thickness of modified Drift is piled up at the junction of Tunkhannock creek with the Susquehanna river, extending in a broad sheet to 125′ above the level of the latter, or to 735′ A. T. The same deposit can be traced up Tunkhannock creek at the same level for several miles, until its top gradually reaches the bed of the stream by the constant rise of the latter. Hence the deposit is clearly *modified Drift* material transported into the valleys of the two streams and dumped down there by running water, during the *flooded river epoch* that marked the retreat of the Northern Ice sheet.

A ridge or "*kame*" of this modified Drift crowns the summit of the deposit, beginning a short distance back from the mouth of the creek and extending along its valley for

about one half mile. It is quite steep on both sides and 40′–50′ high.

These gravel deposits extend down to a great depth in the borough of Tunkhannock, as I could not learn that any of the wells had passed entirely through them.

A tusk of the Mastodon was dug out of these gravels in excavating one of the streets at Tunkhannock, and is said to have been quite well preserved.

The rocks of this township belong entirely to the *Catskill series;* though a high peak (2000′ A. T.), 3 miles east from the borough of Tunkhannock, extends nearly to the base of the *Pocono-Catskill.*

Flagstone has been quarried at several localities along the Susquehanna river, and elsewhere in the township.

One of these quarries is near the western line of the township, on the land of Mr. Daniel Walters, 75′ above the track of the Lehigh Valley R. R., or 685′ A. T. The flags are of a bluish-green color, and quite smooth.

Messrs. Michaels & Dunlap have a quarry in these rocks about ½ mile further down the river.

In descending the steep bluff of the Susquehanna at this locality the following section was got:

Michaels & Dunlap Section, (Fig. 40, page 122.)

1. Sandstone, massive, ... visible,	10′
2. Concealed, with some *red rock,*	75′
3. Sandstone, greenish-gray with very little red rock interstratified, (CLIFFS.)	150′
4. Quarry rock, ...	20′
5. Concealed, and greenish-gray flags to level of Susquehanna river, ...	330′
	585′

No. 3 makes a great vertical wall along the top of the bluff.

Very fine large flagstones of a bluish-green color are obtained from No. 4.

Lake Carey, or Marcy's Pond as it is frequently called, projects into the northern portion of this township; and the hills just west from it are covered with *glacial striæ* trending S. 35°–40°W. They are finely exposed along the Wilkes-

Barre and Montrose turnpike at an elevation of from 1150′ to 1200′ A. T.

This succession is seen in descending from the pike to Lake Carey near the northern line of the township.

Lake Carey Section, (Fig. 41, page 122.)

1. Sandstone, exhibiting *glacial striæ*,	25′
2. *Red shale*,	25′
3. Sandstone, green,	10′
4. *Shales, red, sandy*,	25′
5. Sandstone, grayish-green,	20′
6. Concealed to level of Lake Carey, (950′ A. T.,)	160′
	265′

The glacial furrows on No. 1 go S. 40° W.

Many large bowlders of *calcareous breccia* are scattered over the concealed interval, No. 6, but they have evidently been transported from the north, and most probably from the horizon of the *Cherry Ridge group.*

Osterhout's creek empties into the Susquehanna river near Le Grange, at the south-eastern corner of the township. Its upper waters flow over a drift-buried valley with a sluggish current; but about three fourth miles from its mouth it cuts through the drift heaps, and then descends in cascades, giving splendid water power.

Cascade.—Just below Osterhout and Jenkins' saw-mill the water falls vertically 30′, where the following succession was obtained in passing down to its mouth :

Osterhout Creek Section, (Fig. 42, page 122.)

1. Hard green sandstone,	10′
2. *Red shale*,	10′
3. Sandstone, green,	10′
4. Concealed,	60′
5. *Calcareous breccia*,	3′
6. Sandstone, greenish-gray,	20′
7. Concealed to level of Susquehanna river, (565′ A. T.,)	65′
	178′

Much drift occurs along the valley of Osterhout's creek above the falls.

Barometric elevations in Tunkhannock.

	A. T.
By-road on Wilkes-Barre pike near J. Broughton's, ...	750′
Forks of road near Mrs. Tuiton's, ...	920′
Forks of road next north, ...	1035′
Forks of road near A. Stark's, ...	1090′
Summit just north of last, ...	1140′
Meadow Brook at pike crossing, ...	975′
Summit next north, ...	1190′
Lake Carey, ...	950′

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5. *Lemon township.*

This area lies directly north from Tunkhannock, and borders the Susquehanna line.

Meshoppen creek passes across its north-western corner, while the rest of its surface drains southward into Tunkhannock creek.

Several lakelets occur in this township, among which are Carey, Mud, and Ox-bow ponds. The first occupies a wide *buried valley* in which the East Branch of Meshoppen creek found an exit to the Tunkhannock in pre glacial times. This seems certain from the occurrence of a low, drift-filled gap at the head of the lake, only 90′ above the level of the same, the hills on either side rising 200′ higher, while from the summit of this gap an old drift-filled valley leads directly north to Meshoppen creek.

The rocks of this township belong to the *Catskill* and *Catskill-Chemung beds.*

A Spirifer bed apparently belonging in the latter group is exposed in a cut on the Montrose R. R. about one half mile north from Lemon station at an elevation of 1020′ A. T. It is 4′ thick and overlain by 10′ of green sandstone. In it occur forms resembling *Spirifera disjuncta;* but as none of them could be freed from the stony matrix, the identification is very doubtful.

Origin of cornstone.—The occurrence of these shells in a *calcareous breccia* in every way resembling the *cornstones* of the *typical Catskill*, suggests the idea that the lime in the *cornstones* of the latter was probably obtained from

shells so broken and triturated as to be generally unrecognizable.

A bowlder of this same stratum was seen near the northern line of the township, and ½ mile south-east from Avery station, at an elevation of 1130′ A. T.; while 50′ above it a cliff of massive, greenish-gray current-bedded sandstone extends around the hills.

Glacial striæ going S. 35°—40° W. occur along the road near D. K. Brown's.

Two terraces are seen along Tunkhannock creek at the south-eastern corner of the township; one 15′ above the level of the stream, composed of fine silt and sand; the other 50′ above stream level, (680′ A. T.)composed of small, rounded bowlders. Its escarpment is quite steep, and a wide level reach spreads out on its top.

Barometric elevations in Lemon.

	A. T.
Lake Carey,	950′
Mud Pond,	1050′
Forks of road near G. Wallace's,	1140′
" " " " M. Avery's,	1110′
Brook next south-east from last,	1080′
Forks of road near D. K. Brown's,	1230′
Summit next S. E.,	1250′
Forks next south-east from last,	1240′
Brook next east (½ m.,)	1125′
Forks at H. B. Travis',	1300′
Cross-roads near S. Decker's on Horton's creek,	1050′
Creek (Horton's) here,	1030′
Tunkhannock creek at G. Brown's,	670′
Forks of road near N. D. Stark's,	685′
" east from M. E. Ch. at eastern line of township,	730′

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6. *Nicholson township.*

This occupies the north-eastern corner of the county, abutting against Susquehanna on the north, and Lackawanna on the east.

It is drained by Tunkhannock creek, which enters it at the extreme north-east corner from Susquehanna county, and flows entirely across the township, passing out at its south-west corner.

The rocks belong to the *Catskill series*, the highest beds extending up to the horizon of the *Cherry Ridge group*.

Martin's creek puts into Tunkhannock from the north at Nicholson; and along it the *Catskill sandstones* make long lines of cliff far up toward the summit of the hills. One of these sandstones is seen about one half mile north from Nicholson, making a long, high cliff on both sides of the valley, and 300′ above the same; its base 1025′ A. T.

At Nicholson the following succession was obtained in descending the steep hill just east from the borough:

Nicholson Section (Fig. 43, page 122.)

1. Sandstone, greenish-gray, massive,	15′
2. *Calcareous breccia,*	6′
3. Sandstone,	10′
4. *Red shale,*	30′
5. Concealed,	80′
6. Sandstone, massive,	10′
7. Concealed,	80′
8. Sandstone, (*quarried,*)	15′
9. Concealed,	15′
10. Flaggy sandstone, (QUARRY,)	10′
11. Concealed to R. R. level (766′ A. T.),	40′
12. Concealed,	20′
13. Massive, greenish-gray sandstone to level of Martin's creek,	20′
	301′

The calcareous breccia, No. 2, imbedded between two sandstone beds, seems to be continuous at this locality; and great blackened bowlders of it lie scattered over the hill below. It is very probably the parent bed of that class of bowlders found all along Martin's creek valley, both in this county and in Susquehanna to the north.

Flagstone Quarry.—The flaggy sandstone, No. 10, is extensively quarried at Nicholson and furnishes very smooth flagstone of a greenish-gray color, and 2″–4″ thick.

No. 8 of comes down to R. R. level in a cut, and has been quarried for flagging about three fourths of a mile below Nicholson.

One half mile further south along the R. R., a massive sandstone, (which occurs in the concealed interval No. 5,) comes into the hill at 45′ above the R. R. (890′ A. T.) It

makes a long line of cliffs on the opposite or west side of Tunkhannock creek; and 35′ above it comes the base of another cliff rock seen along the R. R., with the *red shales*, (No. 4,) exposed for 10′ directly below.

At the north end of the tunnel near the southern margin of this township, the following was obtained:

D. L. & W. Tunnel Section (*Fig. 44, page 128.*)

1. Sandstone, greenish gray,	30′
2. Concealed,	100′
3. Sandstone, massive, greenish gray,	20′
4. Shales and flaggy sandstone to level of R. R. track,	45′
	195′

Copper Ores.—The D. L. & W. R. R. passes across this township from north to south, and at the southern margin of the same, crosses a high divide between Tunkhannock creek and its South Branch, through a long tunnel. In the deep cut leading up to this tunnel from the north, several small pockets of *Copper ore* were found, principally *carbonates*, in masses of 1 to 3 lbs. according to report. The occurrence of the copper gave rise to the expectation that it would be found in paying quantities in that vicinity, and much time has been spent by some parties in a fruitless search for *Copper*, *Silver*, *Lead*, and other metals in this township.

Slight traces of *Copper*, *Lead* and *Nickel* and sometimes *Zinc*, are found in the *Catskill rocks* very frequently; but always in such minute quantities that mining can never be profitable; for the simple reason that no genuine–fissures have ever been found penetrating these beds; and from the facts in hand are very unlikely ever to be found. So it will be wholly a waste for the citizens of Nicholson to spend either money or time in exploring for such or any other ores within the boundary of their township. Occasionally rich nodules of these ores may be found occupying small cavities or joints in the rocks; but even if all the joints were filled with *copper ore* its extraction would be more expensive than profitable where the enclosing rock is so hard, and the space occupied by the joints so small.

Glacial striæ going S. 35° W. occur on the summit of the hill, at 1175′ A. T., a short distance west from West Nicholson village, near C. H. Riker's.

A short distance further east, a trench several feet wide, and two to three feet deep, conformable with the slope of the hill, seems to have been plowed out by the ice moving S. 37° W. at 1125′ A. T.

A calcareous breccia containing *fish bones* is scattered in large bowlders over the surface a short distance north from West Nicholson at 1075′ A. T.

Large conglomerate bowlders are seen along the road between School-House No. 8, and West Nicholson, the quartz pebbles being generally angular, and some of them rose colored. They occur on the highest summits, (1300′ A. T.) and doubtless are the remnants of the *Cherry Ridge conglomerate*, the horizon of which overshoots most of the hills in the township except along its southern edge.

High cascades occur on Stephen's run, which puts into Tunkhannock creek two miles below Nicholson; one of them near the mouth of the stream being 75′ high over successive, hard, greenish-gray sandstones, separated by green and *red* shales.

Two terraces occur along Tunkhannock creek, near the cemetery above Pierceville; one at 15′ above the creek (695′ A. T.) composed entirely of sand; the other 25′ higher (720′ A. T.) composed of small water-worn bowlders.

Barometric elevations in Nicholson.

	A. T.
Horton's creek at V. Reynolds,	1030′
Forks of road near C. H. Riker's,	1175′
West Nicholson,	1030′
Bartholomew creek at West Nicholson,	1000′
Forks just east from S. Barker's,	1150′
Stream at road crossing near E. Stephen's,	990′
Forks at School-House No. 8,	1100′
Forks of road near L. Billings',	1150′
Stephen's run near J. Stephen's,	1000′
Forks of road at mouth of Stephen's run,	725
" " " 140 rods S. W. of last,	715′
Tunkhannock creek just opposite last,	680′
Forks of road in Pierceville,	700′

7. *Clinton township.*

This township on the Lackawanna county line, with Nicholson to the north of it, and Overfield to the south of it, spreads over the highland of *Catskill rocks*, through which the deep valley of the Tunkhannock east branch has been excavated.

The Delaware, Lackawanna and Western railroad follows this valley for 3 miles past Factoryville; entering from a ravine from the south; and leaving it to ascend another ravine on the north.

Trout brook also cuts down from the highland south of the valley.

The geology of the township is precisely the same as that of the townships on each side of it.

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8. *Overfield township.*

This township borders Tunkhannock on the west and Lackawanna county on the east. The northern half drains into South Tunkhannock creek, while the rainfall on the southern half goes direct to the Susquehanna river through Osterhout's and Buttermilk creeks.

The present drainage of this area is entirely different from what it was in pre-glacial times, the immense deposits of morainic débris left in its valleys by the retreating *Ice sheet* having completely disarranged the previous drainage system.

Crooked Lake, or *Lake Wynola* as it is sometimes called, is a large body of water situated in an old valley of *pre-glacial erosion* in the south-western portion of the township. It has a maximum depth of 65′, as I determined by a series of soundings, and an elevation of 1000′ A. T. Bar. A low ridge of drift only 25′ above the surface of the lake separates it now from an old drift-filled valley (in which no stream now flows) leading westward and debouching into the valley of Osterhout's creek. The outlet of the lake runs along through drift deposits, with a gentle fall, until it cuts down to the level of its present bottom. Here rock

outcrops appear, over which it descends in a continuous series of cascades (935'—825'=)110' in less than ¼ mile, i. e. from the first cascade to where it empties into Buttermilk creek below Mill city.

Preglacial Valley.—Now, from these facts it is perfectly plain that *Crooked Lake* was formed from the damming up by drift of a pre-glacial valley, which had been excavated by a stream then flowing into Osterhout's creek; the dam of morainic material being sufficiently high to raise the water in the lake to such a point that it found an exit to the south-west into the valley of Buttermilk creek. This explains the precipitous character of the present stream bed where it empties into the valley of the latter; for this rapid portion of its descent is evidently over what was in pre-glacial times merely the bounding wall of the Buttermilk valley.

Rate of erosion.—It is evident from the above-mentioned facts, that the erosion of the narrow gorge in which the Crooked Lake outlet now flows, has been accomplished since the retreat of the Northern Ice sheet.

Crooked Lake has an area of about six hundred acres, and is surrounded by beautiful groves which render it a desirable summer resort. It is plentifully stocked with Eels, Perch, Sunfish, Suckers, and Bullhead, though, on account of the great depth of the water, angling is not always successful.

Barometric elevations in Overfield.

	A. T.
Crooked Lake,	1000'
Forks next N. E. from Mrs. C. E. Depew's,	1020'
Summit at A. Secor's, between Crooked Lake and Osterhout's creek,	1025'
Forks at S. Gregory's,	1100'
Forks at H. Burgers',	995'
Level of Crooked Lake outlet just east,	980'
Crossing of outlet one fourth mile south of last,	950'

9. *Falls township.*

This lies directly south from Overfield, having the Sus-

quehanna river for its south-western border, and Lackawanna county on the east.

Buttermilk creek is the principal draining stream, which flows southward through it into the Susquehanna river. The course of this stream near its mouth was entirely changed by the effects of *glaciation;* so that the beautiful *Buttermilk falls* are of post-glacial origin, the vast heaps of Drift left piled up in the old channel about the mouth of the ancient stream having diverted the course of the creek and caused it to flow over the *Catskill cliffs* into the Susquehanna. The evidence of this change in the course of Buttermilk creek is singularly clear and conclusive.

Buttermilk falls.—The beginning of the Falls is opposite the Union church, ⅛ mile above the mouth. On above this the creek flows over Drift deposits; but cutting through them at the top of Buttermilk Falls descends in four successive leaps of 10′, 15′, 25′ and 25′, respectively, through a vertical distance of 80′, over hard, greenish-gray *Catskill* sandstones, which have no interstratified *red* beds. This descent is accomplished in a horizontal distance of 200 yards along which the stream has excavated a deep narrow gorge. At the base of the Buttermilk Falls the stream descends rapidly to near its mouth, where it makes two other cascades of 20′ and 35′ respectively, the last one carrying its waters directly into the bed of the Susquehanna river. The entire descent from the top of the Buttermilk falls to the river is 715′—560′=155′.

The *pre-gacial channel* of the creek may be followed from a few rods above the beginning of Buttermilk Falls, across a broad heap of drift, (extending to 745′ A.T.) eastward into the valley of a small stream, which now flows through drift deposits, making no falls whatever, and emptying into Buttermilk creek just below the foot of Buttermilk Falls. From this point onward to the Susquehanna the old *filled-up channel* of the creek passes along just east from the present one, the road which descends the east bank of the stream occupying its center. The rocks over which the lower falls are made, near the Lehigh Valley R. R. are seen to be suddenly cut away, and the channel filled with *Drift;*

so that the ancient stream emptied into the Susquehanna within two or three rods of its present mouth.

The rocks of this township belong to the lower portion of the *Catskill series.* They make excellent flagging as usual, and several small *quarries* have been opened on them in this township.

Two beautiful terraces occur along the Susquehanna river one mile above Falls station, the lower constituting the present flood plain of the river, and its top coming 30′ above low water, or 590′ A. T. It is composed principally of river sand and silt, and is about 150 yards broad.

The second or *upper terrace* rises with a very steep escarpment abruptly from the top of the first to an elevation of 95′ at its highest point or 125′ above river level. It is composed largely of small rounded bowlders; many *metamorphic*, the largest seen being a *gneissoid bowlder* 4″ in diameter. All the bowlders of this class are rounded and polished.

Barometric elevations in Falls.

	A. T.
Forks of road next south-west from Mill City,	895′
Forks south from M. Walter's,	925′
" at B. Place's,	800′
" 100 rods next south,	765′

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10. *Eaton township.*

This area lies west from Falls township, having the Susquehanna river as its northern and eastern boundary for a distance of 15 miles.

Bowman's creek flows northward through its center to the Susquehanna river, one mile below Tunkhannock.

The rocks of this township belong principally to the *Catskill series*, but a few of the highest knobs, like the *Miller Mountain*, 3½ miles south from Tunkhannock, extend up to the *Pocono-Catskill beds.*

Miller mountain rises with a very steep escarpment from the river bank to an altitude of 1600′ above the same, or to about 2175′ A. T. being one of the most elevated points in

the county. It is capped by hard, gray sandstones not far below the base of the *Pocono series*. In descending from its summit, the following section was obtained:

Miller mountain Section (*Fig. 45, page 128.*)

1.	Concealed with some outcrops of massive, gray sandstone (*Pocono-Catskill*),	135′
2.	Gray sandstone, massive,	10′
3.	Concealed,	50′
4.	Sandstone, flaggy, grayish-green,	10′
5.	Concealed,	75′
6.	Sandstone, gray, current-bedded,	25′
7.	Concealed, with some *red beds*,	560′
8.	Sandstone, green, current-bedded, visible,	5′
9.	Concealed,	360′
10.	Sandstone, massive, current-bedded,	10′
11.	Concealed and greenish-gray sandstone to level of Susquehanna river at mouth of Bowman's creek (575′,)	350′
		1590′

The summit of this knob covers many acres, but the surface falls rapidly away to more than 1000 feet lower in every direction, leaving it apparently isolated; a monument of the great erosion to which this region has been subjected.

No *glacial scratches* are to be seen on the rocky top; so that it seems as if this knob rose above the limit of glaciation.

Moneypenny's Glen is a deep gorge cut out of hard green sandstones by a small stream which empties into the Delaware river near South Eaton. At the head of the glen the stream makes a nearly vertical plunge of 50′ over hard sandstone, into a narrow channel with rocky walls, overhung with a dense forest growth; and continues in it to the river, one mile away, making an enchanting summer retreat.

Terraces.—Three, and sometimes four, terraces are seen in the vicinity of Mr. B. M. Hall's opposite Le Grange. The first of these makes the flood-plain of the Susquehanna, and its top is 30′–35′ above low water; the second rises abruptly to 100′ above low water and is largely composed of small rounded bowlders, among which are many of *metamorphic origin;* the third rises to 150′ above river level; the fourth reaches an elevation of 200′ (about 775′.)

In some places its top is marked by a deposit of fine,

white, siliceous clay. This deposit occurs near Mr. W. B. Moneypenny's at an elevation of 770′ A. T. It is possible that this bed marks the upper limit of the *Champlain flood.*

The following section was made at the western line of the township, in descending along the road from Mr. J. Luce's to the Mehoopany township line.

J. Luce's Section, (Fig. 46, page 128.)

1. Green sandstone, visible,	40′
2. *Montrose Red shale*, sandy, interstratified with several green sandstones 5′-10′ thick,	210′
3. Greenish-gray sandstones with very little red shale to level of the Susquehanna river, (595′ A. T.,)	420′
	670′

The top of the *Montrose bed* has an elevation of 1225′ A. T. at this locality, or (1685—1225′,) 460′ lower than the same horizon at Montrose, in Susquehanna county 25 miles north 20° east.

Glacial striæ, going S. 40° W., and some S. 35° W. occur on the top of No. 1 at 1265′ A. T.

Barometric elevations in Eaton.

	A. T.
Forks of road north of Eaton P. O.,	620′
Bowman's creek at Eaton P. O.,	600′
Forks of road in Eaton P. O.,	620′
Forks of road near W. Lee's,	700′
Summit of road on terrace, near W. Benedict's,	745′
Road at B. M. Hall's,	645′
Forks of road near C. E. McVicar's,	635′
Forks of road opposite mouth of Sugar Hollow,	650′
Bowman's creek here,	635′
Forks of road near L. Harding's,	695′
Crossing of Bowman's creek next south,	680′
Road at south line of township near M. C. Moyer's,	760′
Forks of road at W. H. Dana's mill,	680′
Level of mill dam just above,	720′
Forks of road near Joe Miller's,	775′
Sugar Hollow creek, at crossing next above last,	775′
Sugar Hollow creek near G. Drakes,	825′
Forks of road next west,	890′
Forks of road near Jayne's school-house,	1125′
Forks of road near A. Lewis',	1225′
Summit of road next above, near J. Luce's,	1280′

11. Mehoopany township.

This township borders the south bank of the Susquehanna river next north-west from Eaton, having Forkston on the south. It is drained by Big and Little Mehoopany creeks, which, flowing eastward across the district, enter the Susquehanna within half a mile of each other.

The rocks belong principally to the *Catskill series*, though in the extreme southern portion a small area of *Pocono* caps the summit of the mountains.

Glacial débris in vast heaps lines the banks of the Susquehanna, and its principal tributaries in this township filling the valleys to a height of more than 200′ above the present streams. These deposits are especially noticeable along the valley of Mehoopany creek, where it unites with the Susquehanna, and also at many points along its entire course through the township. Near its western line they extend, as a great *bowlder bed*, up to 235′ above its level or 950′ A. T. These bowlder beds which mark the courses of the valleys seem to be composed mostly of *Drift materials* that have been rehandled, being shed by erosion from the surrounding hills.

Many *small crystalline bowlders* are seen along the Susquehanna, and a few in the Mehoopany valley.

Barometric elevations in Mehoopany.

	A. T.
Forks of road near J. Jayne's,	1000′
" " " at Maynard Hill,	910′
" " " near H. Furman's,	930′
Crossing of road over Furman's run,	730′
Level of Mehoopany creek at mouth of Furman's run,	715′
Level of Mehoopany creek at road crossing one mile above its mouth,	635′
Level of Susquehanna river at mouth of Mehoopany creek,	605′

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12. Windham township.

This lies directly west from Mehoopany township, along the Susquehanna river to the Bradford county line.

The rocks belong entirely to the *Catskill* and *Chemung-Catskill*, except along the immediate valley or channel of

Plate XIII.

Fig. 48: Dutch Mountain section, Pocono and Catskill rocks, continued as Mehoopeny No. 1 Well record

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the Susquehanna river at the north-western corner of the township where that stream has cut down to the top of the *Chemung beds.*

The entire township has suffered much change in its topography from *Glacial agencies*, its ancient valleys having been filled up with morainic débris and one of them, Little Mehoopany, converted into a chain of lakelets.

The western portion of the township is a low swampy region covered with *Drift* deposits in which the divide that separates the waters of the Mehoopany creek from those which go westward into Bradford county is scarcely perceptible; in fact the Susquehanna may have passed across this divide (summit 1100′ A. T.) into the valley of Big Mehoopany creek.

This, however, is mere conjecture and has nothing to support it except the universal spread of what appears to be rehandled Drift materials over the region in question as well as the occurrence of *small metamorphic bowlders* over the same region and along the Lovelton branch of Mehoopany creek, these being the only localities in this district where I have seen them at any considerable distance away from the valley of the Susquehanna.

Opposite Black Walnut Station, the Susquehanna washes its southern shore, and green sandstones rise in a nearly vertical wall to an elevation of 260′, exhibiting the following succession:

Section opposite Black Walnut Station (*Fig. 47, page 128*).

1. Greenish-gray sandstone,	40′
2. *Red shale*, sandy,	20′
3. Greenish-gray sandstone, massive,	25′
4. Quarried sandstones, flaggy and massive to level of river (615′ A. T.),	175′
	260′

The basal members of No. 4 have been quarried extensively along the south bank of the Susquehanna for flags and building stone.

Only a few thin streaks of *red shale* were seen in the entire 175′ of rock represented by No. 4.

Glacial striæ were observed on a bed of *red shale* near the outlet of Chamberlin's pond, going S. 38° W. at an elevation of 1090′ A. T.

Barometric Elevation in Windham.

Forks of road near T. J. Wright's,	870′
Summit of ridge on bluff of Susquehanna river, just south of last,	875′
Level of Susquehanna river opposite Black Walnut,	615′
Forks of road 33 rods west of T. J. Wright's,	895′
Level of Wright's run at crossing here,	890′
Forks of road 165 rods south of last,	1065′
" " " at W. R. Allen's,	1095′
Summit of road between Allen's and the preceding,	1175′
Chamberlin's Pond,	1060′
Jennings' "	1000′
Nigger "	1085′
Sharp's "	1145′
Forks of road near S. W. Gary's,	1140′
" " " " Riley's School-House,	1135′
Cross-roads at W. Drake's,	1315′

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13. North Branch township.

This township lies immediately south from Windham, bordering Bradford and Sullivan counties on the west. Its rainfall all passes eastward to the Susquehanna river through Big Mehoopany creek, except from a small area at the extreme northern portion, which reaches the same river northwestward through Bradford county.

The rocks of this township belong principally to the *Catskill series.*

Dutch Mountain, a large region in the southern part, is capped with *Pocono.*

The northern half only, or *Catskill area*, of the township is cultivated, the *Pocono area* being a wild, pathless region, clad with its primeval forest, on a broad and almost level plateau at an elevation of 2100′–2200′ above the sea. Numerous large *swamps* cover this region, and travel through it is almost impossible except with the most skillful guides.

The Mehoopany Oil Company drilled a test well for oil

on the bank of the Mehoopany creek, one and one half miles north-west from Lovelton, near the residence of C. R. Adams, almost under the shadow of Dutch Mountain, which rises abruptly nearly 900′ higher than the mouth of the well, which begins at 1350′ A. T. Bar.

The well was drilled to a depth of 2089′, and a very careful record kept by Mr. Judson Stark of Tunkhannock, one of the directors of the company, who personally examined every sand-pumping from a depth of 800′ to the bottom of the hole and kept samples of the most of them in bottles duly labeled with depth, &c. These bottles, about one hundred in number, I was permitted to examine and to take what "notes" had been made on the record during the progress of the boring.

Just below where the well was bored a small stream, draining a large area from the Dutch mountain plateau, falls over the elevated escarpment of the *Pocono rocks*, and descending through the *Catskill beds* in a series of cascades, gives a nearly perfect exposure for several hundred feet.

Combining this section with the Mehoopany well record the following succession was obtained:

Dutch mountain section and Mehoopany No. 1 well record (Fig. 48, page 138.)

1.	*Griswold's Gap conglomerate*, a very massive, grayish-white rock, filled with large quartz pebbles, visible	30′
2.	Concealed, (shale interval,)	30′
3.	Sandstone, massive, grayish, makes a cascade 75′ high,	70′
4.	*Red shale*, sandy,	5′
5.	Sandstone, gray,	20′
6.	Concealed, (shales,)	45′
7.	Sandstone, greenish-gray, makes a great cascade,	90′
8.	*Red shale*,	10′
9.	Sandstone, greenish-gray, somewhat massive, nearly all cascade,	130′
10.	*Red shale*,	25′
11.	Sandstone, greenish, flaggy,	55′
12.	*Red shale*,	35′
13.	Sandstone, greenish, (cascade,)	25′
14.	Concealed,	10′
15.	Sandstone, greenish,	20′

16. Concealed,			85'	
17. Sandstone, greenish, (cascade,)			20'	
18. *Red shale,*			10'	
19. Sandstone, green, (cascade,)			15'	
20. *Red shale,*			10'	
21. Sandstone, green, (cascade,)			20'	
22. *Red shale,*			30'	
23. Sandstone, green, massive, (cascade,)			30'	
24. *Red shale,*			10'	
25. Sandstone, greenish, (cascade,)			20'	
26. *Red shale,*			30'	
27. Sandstone, grayish-green, (cascade,)			40'	
28. *Red shale* to the same elevation (1350' A. T.) as the mouth of the Mehoopany well ½ mile west, rocks practically horizontal,			5'	= 875
29. Bore hole begins here with conductor through Drift,	0' to	38'	38'	
30. No record kept of upper portion of well for 800', which was through alternate beds of sandstone and red shale,	38'	792'	754'	
31. Sandstone, whitish, with some gas, ("1st oil SS.")	792'	800'	8'	
32. *Red rocks,*	800'	1000'	200'	
33. Grayish-green sandstones and *red rocks,*	1000'	1175'	175'	
34. Whitish sandstone,	1175'	1200'	25'	
35. Not recorded,	1200'	1275'	75'	
36. Sandstone, hard reddish,	1275'	1300'	25'	
37. *Red shale,*	1300'	1320'	20'	
38. Sandstone, gray, hard,	1320'	1350'	30'	
39. Sandstone, grayish-white, with small quartz pebbles, "2d oil SS." of the driller's record,	1350'	1380'	30'	
40. Bluish-green shales,	1380'	1430'	50'	
41. Sandstone, gray,	1430'	1433'	3'	
42. Not recorded,	1433'	1485	52'	
43. *Big Red rock* of driller,	1485'	1525'	40'	
44. "Blue Monday" of driller, a bluish-green, hard sandstone,	1525'	1550'	25'	
45. Not recorded,	1550'	1560'	10'	
46. "*Little Red rock*" of driller,	1560'	1585'	25'	
47. Sandstone, hard, blue micaceous,	1585'	1590'	5'	
48. "Stray 3d SS.," a grayish-green rock with smell of gas,	1590'	1610'	20'	
49. *Red shales* and reddish sandstone with small *show of oil,*	1610'	1617'	7'	
50. Sandstone, greenish-gray,	1617'	1632'	15'	
51. *Red shales,* sandy,	1632'	1663	31'	
52. Sandy beds, hard gray, "4th sand,"	1663'	1721'	58'	
53. *Red shale,* sandy,	1721'	1733'	12'	
54. Hard gray, sandy beds,	1733'	1753'	20'	

55. Dark blue and blackish sandy shale,	1753'	1833'	80'	
56. *Purple shales*, sandy, ...	1833'	1885'	52'	
57. Sandstone, greenish-gray, ...	1885'	1895'	10'	
58. Whitish, pebbly sandstone with some *oil*, ...	1895'	1904'	9'	
59. Gray sandstone, ...	1904'	1909'	5'	
60. Shale, dark sandy, ...	1909'	1914'	5'	
61. Sandstone, light gray, ...	1914'	1919'	5'	
62. Shales, blue, sandy, ...	1919'	2061'	142'	
63. Shales, greenish, mixed with purple, the latter possibly fallen in from above, to bottom of hole, ...	2061'	2089'	28'	= 2089
Total length of section, . . .				2964

The following notes were transcribed from Mr. Stark's record: "Began drilling October 24th, 1881, and finished March 15th, 1882; fresh water cased off at 280'; salt water cased off at 665'; small spray of brackish water at 1000', and another in 'stray 3d sand'; show of oil 1590'-1663'; torpedoed at about 1640' in *red rock;* 'black soot' at about 1700 feet."

The terms "1st," "2d," "3d," "Stray," and "4th sandstones" in this record are the mere suppositions of drillers familiar with the Butler and Clarion oil fields, and are of no value at such a distance.

From the character of the borings, I am inclined to place the base of the *Catskill beds* at the top of No. 34, or 1175' down in the well; and the top of the genuine *Chemung* at No. 57, or 1885' down in the well; thus giving the *Chemung-Catskill beds* a thickness of 710'; and the interval from the *Griswold's Gap conglomerate* to the top of the *Chemung*, 2730'.

The *transition beds* from *Pocono* to *Catskill* are represented in this section by Nos. 2-9 inclusive; a series of massive, gray, current-bedded sandstones, that weather to a yellowish hue, and some of them slightly pebbly; the whole group being 400' thick, in which occurs only 15' of red material. Subtracting the thickness of the *Transition beds* from the measures given above, we have remaining 1620' for the *Catskill.*

The Griswold's Gap conglomerate makes the broad summit of Dutch mountain at an elevation of 2200'-2250' above

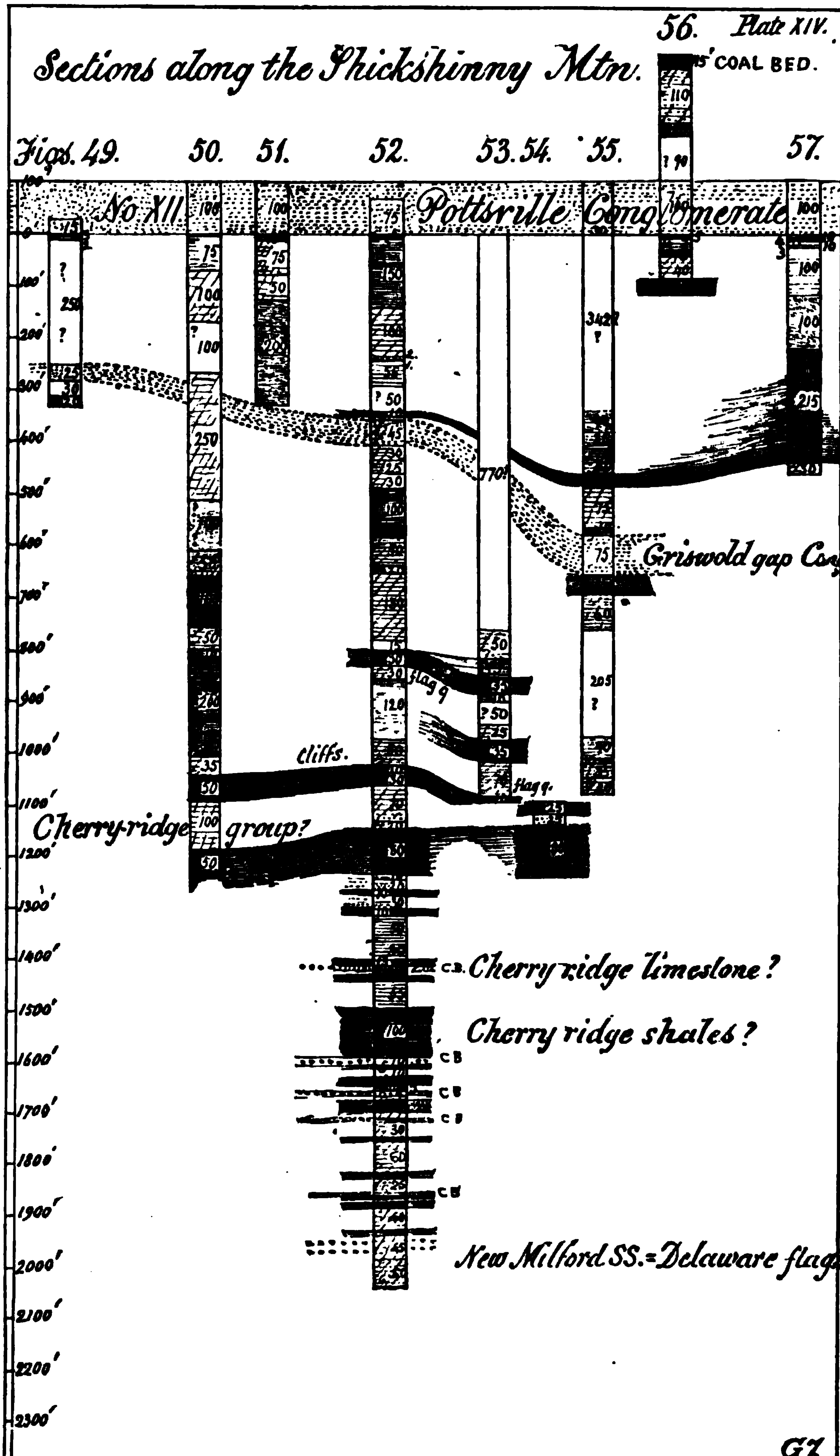

Plate XIV.
Sections along the Shickshinny Mtn.
Figs. 49. 50. 51. 52. 53. 54. 55. 56. 57.
15' COAL BED.
No XII. Pottsville Conglomerate
Griswold gap Cong.
cliffs.
flagg.
Cherry-ridge group?
Cherry ridge limestone?
Cherry ridge shales?
New Milford SS. = Delaware flags
G7

the sea. The rock is very massive and filled with large quartz pebbles. It makes a great cliff, 30′ high, along the summit of the mountain, and many large bowlders from it are strewn over the lower levels. There can be no doubt of its identity with the *Griswold's Gap conglomerate* of Wayne county, since it comes at the right horizon for that stratum and has much the same appearance in every respect. It thus becomes a valuable horizon from which to correlate the rocks of the eastern portion of Pennsylvania with the beds to the west, and is especially valuable in the present section for furnishing a well known horizon from which to measure downward through the *Transition series* and *Catskill.*

The 400′ *transition Pocono-Catskill group* makes an almost precipitous wall around the brow of Dutch mountain; and the little stream makes an almost constant cascade, sometimes leaping 75′–100′ vertically.

The course of the stream through the *Catskill beds* is marked by a constant succession of cascades, there being a vertical fall of 10′–40′ over every *sandstone;* the beds of *red shale* making the level reaches from one fall to the next.

The Mt. Pleasant conglomerate seems to be represented by the basal portion of No. 9, which is quite massive for 30′–40′ and slightly pebbly.

The Mt. Pleasant red shale would be represented by 150′–200′ of the alternating *red shales*, and green sandstones which come below No. 9, or possibly a much greater thickness; for they and the *Elk mountain sandstones* doubtless make up all the rest of the section observed along the run, below the *130′ sandstone;* since there is nothing in it that would fairly represent the *Cherry Ridge conglomerate and limestone.*

Just below No. 28 there occur some very massive beds with *calcareous breccias*, and they would represent the top of the *Cherry Ridge group.*

The Montrose red shale seems to end with No. 32, (the 200′ of *red beds* struck in the bore-hole at 800′) but it is possible that No. 33 should also be included in this group, since Mr. Stark reports it as containing much red material.

If the base of the *Catskill-Chemung* be rightly placed in this boring at the top of No. 57 (and this cannot be far wrong,) it would follow that *the "9' white pebbly sandstone"* (No. 58,) which yielded a *"show of oil,"* represents the *Cascade sandstone* of Susquehanna and Wayne, and *Falls creek conglomerate* of Sherwood.

The valleys and hills of the township are deeply covered with *Drift*, but no evidence of its presence was observed on the elevated summit of Dutch mountain, hence it is possible that this region rose above the ice.

The depth of the Drift materials over the hills in the northern portion of the township is about 50′, as learned from the depth of wells to bed rock.

Mr. Drake dug through 46′ of Drift on the summit of a hill 1335′ A. T., before striking bed rock, near the north-eastern corner of the township.

Barometric elevations in North Branch.

Cross roads at W. Drake's,	**1325′**
Forks of road at school-house No. 2,	**1220′**
Level of stream here at road crossing,	**1200′**
Forks of road near Mrs. Frailey's,	**1290′**
Crest of Divide between Mehoopany creek and water going north-west opposite J. B. Burgess',	**1200′**
Level of Mehoopany creek at crossing near P. F. Hope's,	**1045′**
Road opposite Daniel Collin's,	**1050′**
Forks of road near cemetery at Mr. Corcoran's,	**1085′**
Level of Mehoopany creek at crossing near J. Burgess',	**1030′**
Mouth of Mehoopany well No. 1,	**1350′**
Road at store house in Lovelton,	**1020′**
Level of creek at crossing just below last,	**980′**
Forks of road at L. G. Burgess',	**895′**
Mehoopany creek here,	**875′**
Road at Hurlburtsville,	**965′**
Creek (Mehoopany) below mill dam there,	**930′**

14. Forkston township.

This is a very large, irregular area which, beginning at the north line of North Branch township, extends along its eastern border around to its southern margin and southward along the Sullivan county line to the northern border of

Luzerne, thus having something the shape of an hour-glass, and being nearly 20 miles through its longest diameter.

The southern half of the "hour-glass" is a wild and unbroken forest of mountain lands through which no roads pass, and which is never visited, except by the hunter or fisherman.

The Griswold's Gap conglomerate, at the base of the *Pocono*, makes the crests of these mountains, generally known as the South mountains, spreading in a great sheet over several thousand acres at an elevation of more than 2000′ above the sea.

A small area of coal lies along the northern margin of this township where it borders the south line of North Branch.

The coal is of workable thickness, and has been mined for several years by the *Forkston Coal Co.* for local use in the village of Forkston and vicinity.

The mine is in a wilderness country, about 2½ miles north from the road which leads from Forkston through Bella Sylvia to Bernice and Dushore. The following section was obtained at the opening of the Forkston Coal Co.:

Section at Forkston Coal Mine (Fig. 49, page 144).

1. Very pebbly, massive conglomerate,				visible 15′
2. *Coal, Forkston,*	coal, good,	2′ ″	2125′ A. T. Bar.	3′ 2″
	cannel slate,	0′ 4″		
	coal,	0′ 2″		
	slate & bone coal,	0′ 4″		
	coal,	0′ 4″		
3. Dark, sandy shale,				5′
4. Concealed,				250′
5. *Griswold's Gap conglomerate,*				25′
6. Concealed,				30′
7. *Red shale,*				20′
				333′

I feel some hesitation in identifying No. 1 with the *conglomerate of XII* on account of the small interval between it and that of the *Griswold's Gap*, but as the horizontal distance from the outcrop of the coal to the nearest exposure of No. 5 is more than two miles, the interval of 280′ given above might possibly be increased by 100′ or more;

since, as we approach one of these isolated coal basins like that of Bernice, the rocks dip inward toward the center of the trough from all sides. The dip could not be determined here, as everything is covered up for two miles from the coal; with a single exception, where, one mile south from the mouth of the mine, a bed of *red shale* was seen in the roots of an overturned tree at an elevation 5′ higher, topographically than the mouth of the mine.

As these *red beds* might represent the *Mauch Chunk shale*, and certainly underlie the *coal*, I feel disposed to identify it with the *Campbell's Ledge plant bed* at the base of the *Pottsville conglomerate*, near Pittston. See page 43 above.

This coal, No. 2, which may be named the *Forkston bed* is rather slaty in its lower portion, containing much impure cannel or a kind of *bone coal*, while the upper portion is a semi-anthracite, and highly prized as fuel.

As analyzed by Mr. McCreath it exhibits the following composition:

Water,	.612	
Volatile matter,	10.238	
Fixed carbon,	73.480	
Sulphur,	.745	
Ash,	14.925	white.
Total,	100.000	

I was informed by one of the men who has dug coal here that the bed gets to be 4′ thick when well under cover, and does not exhibit any greater irregularities than is usual in coal beds. It underlies a considerable area in the edge of this township, and along the southern border of North Branch, extending westward toward Dushore in Sullivan county. 4,000—5,000 bushels of this coal are annually consumed in the vicinity of Forkston.

The Griswold's Gap conglomerate makes a bold cliff outcrop around the brow of the mountain near Charles Miller's, its base having an elevation of 1875′ A. T. It is filled with quartz pebbles, and huge fragments of the rock cover the surface far down toward the valley of the South Branch of Mehoopany.

A bed of red shale, 20′ thick, comes at the horizon of No. 7; below which grayish-green sandstones, looking much like *Catskill rocks* occur for 300′–400′. They would be the *transition (IX–X) rocks* given in Section 48 near Lovelton from North Branch township.

The Griswold's Gap conglomerate No. 5, of the section, makes a line of cliffs at the summit of the mountain on either side of South Mehoopany creek as we pass down it from Bella Sylvia toward Forkston village, keeping at about the same elevation (1875′–1900′ A. T.) as found in the last section.

A short distance above the mouth of Cassam Brook the Mehoopany Oil Company sunk their test well No. 2, beginninning at an elevation of 1050′ A. T. in the center of the Cassam Brook valley one half mile south from Mehoopany creek.

The drift is here about 60′ thick and contains much quicksand, which caused a great deal of trouble in sinking the conductor to bed rock. For the following notes on the well I am indebted to Mr. Judson Stark of Tunkhannock, one of the directors of the company:

"Drilling was suspended at a depth of 1232′. No systematic record was kept except the general log-book of the drillers, who report a great deal of *red rock* much softer than in the Lovelton well. Large veins of salt water were found, though they were all cased off and the well is now dry; *1st Oil Sand* struck at 975′, some gas and strong smell of oil, sand coarse, brown, 40′ thick; *2d Sand* struck at 1090′, no gas, no oil, sand coarse, white and brown in streaks."

It is extremely improbable that oil in paying quantities will ever be obtained anywhere in Wyoming county.

Much red rock is seen in the hills around Forkston, and it very probably represents the *Cherry Ridge red beds* since it is hardly far enough down in the section for the *Montrose red shale.*

Great heaps of drift are piled up along the south branch of Mehoopany creek, in which very large bowlders occur.

The valley is usually lined with modified drift deposits in a terrace 40′–50′ above creek level.

Barometric Elevations in Forkston.

	A. T.
Mouth of Forkston coal mine,	2125′
Dushore road at Charles Miller's,	1950′
Level of brook at road crossing next east from last,	1380′
Mehoopany creek, (South Br.,) at mouth of Stony Brook,	1080′
Mehoopany creek at road crossing below Slater's saw-mill,	1020′
Mehoopany creek at road crossing near J. H. Rogers',	990′
Mouth of Mehoopany well No. 2,	1050′
Mehoopany creek at crossing south from T. M. Robinson's,	930′
Forkston village at hotel,	790′
Level of South Br. Mehoopany at bridge in Forkston,	760′
Forks of road at Baptist church near P. McQueen's,	760′
North Branch of Mehoopany creek opposite last,	755′
Mehoopany at junction of North and South Brs.,	750′
North Br. Mehoopany at crossing of Lovelton road above R. P. Burgess',	825′

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15. Monroe township.

This lies directly west from the southern half of Forkston, and also borders Luzerne county on the south.

The western half, like the adjoining portion of Forkston, is a wild and unsettled mountain region covered with extensive forests of pine and hemlock, through which the head waters of Bowman's creek meander. This stream rises in Luzerne county on the summit of North Mountain, and entering Wyoming in this township flows north-eastward through its center, draining its entire area.

The rocks belong to the *Pocono* and *Catskill series*, the latter occupying the valley of Bowman's creek and the eastern portion of the township, while the former covers a large portion of the western half and caps the mountains along Bowman's creek.

Drift material fills the valley of Bowman's creek in great heaps, often rising to 100′ above the level of the stream. Much of it has been rehandled and spread out into terraces by the stream, and possibly a large portion of the material has been shed from the hills which adjoin the valley.

Glacial striæ going S. 45° W. occur on hard greenish-

gray Catskill sandstones along the road leading south from Monroe village, near Mr. I. Huneywell's, at the Luzerne county line. Elevation, 1250′ A. T.

Barometric elevations in Monroe.

	A. T.
Forks of road at School-House No. 6,	800′
Road at M. C. Moyer's,	760′
Forks of road at H. Evans',	810′
Crossing of run next west,	830′
Forks at old State road,	820′
Bowman's creek near O. P. Evans',	870′
Forks of road at E. Cook's,	900′
South Br. of Bowman's c'k at May's Mill,	950′
Scovell's Hotel in Monroe village,	1000′
Cross-roads at J. Clark's,	985′
Crossing of run at G. W. Frantz's,	1100′
Forks of road near J. Huneywell's at the Monroe-Luzerne line,	1120′

16. North Moreland. 17. Exeter.

These lie directly east from Monroe, extending to the Susquehanna river, and having Luzerne county for their southern boundary.

The Catskill rocks make the surface outcrops in every portion of these townships, except at the south-east corner of Exeter on the Susquehanna river, where the *Catskill-Chemung* beds are brought up by the Watsontown axis.

The rocks are mostly covered up with *Drift* in these townships, so that very little can be said of them.

Mill Pond is a small lakelet lying partly in Wyoming and partly in Luzerne county at the southern edge of North Moreland. Its basin is surrounded by Drift material and it doubtless occupies an ancient valley of erosion, which the ice filled irregularly with Drift. It is not more than 30′ in depth, and drains northward into Jones' creek, by a short rapid stream making two or three falls of 10′–15′ in each case over *Catskill sandstone.*

Glacial striæ going S. 40° W. occur on a reddish sandstone at the roadside near Mr. R. S. Brown's elevation 1100′ A. T.

Barometric elevations in North Moreland.

	A. T.
Cross-roads at W. N. Brunges',	1110'
Five points roads in Center Moreland village,	1210'
Hotel in Center Moreland,	1230'
Level of stream at crossing near E. Reeve's,	1085'
Cross-roads at R. S. Brown's,	1100'
Elevation of Mill Pond,	1135'

CHAPTER VII.

Township geology of North Lackawanna.

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18. Benton. 19. Greenfield. 20. Fell. 21. Scott.

These townships are situated along the northern border of Lackawanna county in a region that has been swept with *Glacial Ice*, the morainic débris from which covers up the rocks entirely over a large portion of all except Fell.

This last township occupies the extreme north-eastern corner of the county, abutting against Susquehanna on the north and Wayne on the east. The northern end of the Lackawanna coal basin passes through its south-eastern portion.

Catskill rocks make the surface beds of its north-western half, however, and the *Cherry Ridge limestone* may be seen making some outcrops in the vicinity of Crystal Lake.

Benton, Greenfield, and Scott townships have been so littered up with ice débris that many ponds and lakelets were formed by the unequal damming up of pre-glacial valleys, there being eight such *lakelets* in Benton alone. Very few of these *ponds* have any inlets, but are fed from rain water which percolates through the surrounding drift heaps, to rise as springs from the sides and bottom of the ponds.

Crystal Lake, lying partly in Greenfield and Fell, and extending north into the edge of Susquehanna county, has a reported depth of 125′ and its elevation is by Bar. 1750′ A. T.

Catskill rocks, belonging in the series between the *Honesdale sandstone* and *Mount Pleasant red shale*, make the surface beds of these three townships, but so covered by drift that no continuous sections could be obtained.

The coal area in Fell will be described in the future publications of the Anthracite Survey, now in progress under Mr. Ashburner.

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22. *Abington township.*

This is a rudely triangular area, bounded on the north by the South Branch of Tunkhannock creek, and on the west by Wyoming county.

A high range of hills passes east and west across its southern portion, in the vicinity of Clark's Summit; the drainage north is into Tunkhannock creek; south through a gap in the Lackawanna mountains to the Lackawanna river.

The rocks of this area belong entirely to the *Catskill series*, and to that portion of it below the *Mount Pleasant red shale;* mostly grayish-green sandstones, current bedded and massive, with very little *red shale* visible. The sandstones are finely exposed along the cuts of the D. L. & W. R. R., which passes north and south through the district.

Glacial striæ are very well shown on a broad platform of hard sandrock, just west from Dalton, near Mr. A. W. Atherton's. Several square rods of rock are bare at this locality, the entire surface being ground off smooth, and scored with *striæ* going S. 35°–40° W. Some of these scorings are one inch broad and one half inch deep while others are faint thread-like scratches no wider than a pencil mark.

The dip of the rocks over the northern portion of this township is gently (1°–2°) southward, but as we approach the extreme southern point of the same, the dip gradually increases until it is from 5° to 7°.

23. Scranton township.

This area lies directly south from the southern point of Abington township and extends across the Lackawanna valley anthracite coal field.

It is skirted on the north-west by the Lackawanna mountains, composed of Nos. XII and X, through which Leggett's creek has carved a narrow gap southward to the Lackawanna river. The D. L. & W. R. R. passes northward through this gap, and in the cuts along that road the following section was obtained near the northern border of the township:

Section in Leggett's creekgap (Fig. 50, page 144.)

1. *Pottsville conglomerate* basal member, very pebbly,	100'
2. Shales and shaly sandstone,	75'
3. Sandstone, yellowish, rather massive,	100'
4. Concealed,	100'
5. Sandstone, gray, massive, some pebbly,	250'
6. Concealed,	100'
7. Sandstone, grayish-white, massive, pebbly,	50'
8. *Red shales,*	100'
9. Sandstone, greenish-gray,	50'
10. Shales, green, sandy,	10'
11. *Red* and green sandy shales,	200'
12. Grayish-green sandstone,	35'
13. *Red shales,*	50'
14. Massive greenish-gray sandstone with much *calcareous breccia* at base (Cherry Ridge Group?),	100'
15. *Red sandy shales,* visible,	50'
	1270'

The Mauch Chunk red beds are apparently absent entirely at this locality since no *red shales* whatever are seen in the interval between XII and X; but the 75' of rock in No. 2 may be referred to the *Mauch Chunk* horizon.

The Mount Pleasant conglomerate seems to be represented by No. 7 since all the rocks below this belong to the *Catskill series.* This basal bed of the *Catskill-Pocono* is quite massive, grayish-white, and contains many quartz pebbles.

No. 8 is a bed of deep red shale 100' thick which seems to be identical with the *Mount Pleasant red shale* of

Wayne and Susquehanna counties. A decided change in lithology takes place at this horizon, all the sandstones beneath this *red bed* having that peculiar greenish-gray or bluish-green cast which is so characteristic of the Catskill.

Calcareous breccias are seen near the base of the massive greenish-gray sandstones of No. 14, and they may possibly represent the *Cherry Ridge limestone* horizon, and if so, then would No. 15 be the representative of the *Cherry Ridge red shale.*

Along the country road which descends Leggett's creek, the following section was obtained:

Section along Leggett's creek (Fig. 51, page 144.)

1. *Pottsville No. XII Conglomerate,*	—
2. *Dark coaly shales,* (Campbell's ledge,)	10'
3. Sandstone and concealed,	75'
4. Sandstone, massive, yellowish,	50'
5. Shales, sandy, brownish-gray,	200'

The Pocono beds very probably begin with No. 4 of the above section. No. 2 seems to be the representative of the *Campbell's Ledge black slate.*

24. Ransom township.

This is a long triangular area, the apex of which extends to a sharp point along the northern line of Scranton, while the base rests on the Susquehanna river at the west. *Gardner's creek* drains the central portion westward into the latter stream just below Ransom village, while Lackawanna river puts into the Susquehanna at the south border of the township.

The rocks of this township extend from the basal portion of the *Catskill series* up into the Anthracite Coal Measures, No. XIII.

The Lackawannock mountains trend along the southern line of the township, making a range which rises 1200'–1300' A. T. This is the northern rim of the *Lackawanna* or *3d Anthracite coal basin,* and is made by the hard conglomerates of Nos. XII and X. The Susquehanna river

has cut squarely through this *rim* at the south-western corner of the township in a great gap with almost vertical walls of rock on either side of the stream.

The beds of Nos. XII, XI, and X come up from under the *Coal Measures* at an angle of 25°–40°, but as we go northward and descend into the underlying *Catskill*, the strong south-eastern dip gradually slackens to 20°, 15°, 10°, 5°, and finally near the northern edge of the township on the Susquehanna river flattens out almost entirely, and just northward from it in Newton is even slightly reversed, thus marking the presence of the *Watsontown* (*Milton*) *anticlinal* which increasing in height westward from the North Branch brings up the lowest beds of the *Salina* where it crosses the West Branch of the Susquehanna in Northumberland county.

The Lehigh Valley R. R. passes through the gap of the Susquehanna along the old canal tow-path, and in the cuts of the R. R., as well as along the country road which passes through the "Narrows," the following section was obtained, beginning at the upper portion of Campbell's Ledge, near Coxton, and passing up the Lehigh Valley R. R. to the 174th mile-post:

Susquehanna gap Section (*Fig. 52, page 144.*)

1.	*Pottsville conglomerate No. XII*, massive, pebbly conglomerate,	visible 75′
2.	*Campbell's ledge, black shale* containing numerous *fossil plants* and *Insects*,	5′
3.	Sandstone, gray, hard,	3′
4.	*Mauch Chunk, No. XI*, sandstones, flaggy, greenish and sandy shales,	150′
5.	*Pocono Sandstone*, No. X, massive, greenish-gray, makes great cliff at summit of the mountain,	100′
6.	Layer of conglomerate with breccia of shale and sandstone,	2′
7.	Shale, greenish,	1′
8.	Sandstone, gray, massive,	55′
9.	Concealed,	50′
10.	*Red shale*, sandy,	visible 10′
11.	Concealed,	5′
12.	*Griswold's Gap conglomerate?* grayish-white, massive sandstone and conglomerate, pebbles 2″–3″ in diameter near center, upper portion quarried for building stone,	45′

13. Grayish-green, less massive sandstone, few pebbles, . 30'
14. Sandstone, shaly, gray and concealed, ... 25'
15. Massive, gray sandstone beautifully ripple-marked, and having very large quartz pebbles in its base which rests at times with a slight unconformity on the underlying soft green shales, ... 30'
16. Shales, green and concealed, a very little *red* shown, 100'
17. Greenish-gray sandstones, ... 50'
18. Shale, green, thin streaks of red, ... 20'
19. Sandstone, greenish-gray, current-bedded, makes cliffs, 180'
20. Concealed, ... 15'
21. *Red shales*, and concealed, ... 30'
22. Sandstones, greenish-gray and blue, ... 30'
23. Concealed, and sandstone, grayish-green, ... 120'
24. Sandstone, grayish-green, some pebbles, massive, current-bedded, makes cliff at the cascade on the Lehigh Valley R. R., one half mile above Coxton, ... 50'
25. *Red and green shales*, ... 10'
26. *Red shale*, ... 30'
27. Sandstone, massive, greenish-gray, pebbly for 40'-50' from base, ... 70'
28. Sandstone, green, flaggy, ... 20'
29. *Dark-red shale*, ... 80'
30. Sandstone, chocolate-colored, ... 10'
31. Sandstone, greenish-gray, with some pebbles, ... 20'
32. *Red shale*, sandy, ... 10'
33. Sandstone, massive, very pebbly at base, large quartz pebbles, some of them rose-colored, scattered pebbles throughout, ... 30'
34. *Red shale* top passes down to level of Lehigh Valley R. R., 150 yards south of the 173d mile-post, ... 10'
35. Sandstone, green, flaggy, ... 50'
36. " " " to 173d mile-post, ... 30'
37. *Red sandy shale*, ... 13'
38. Sandstone, green, with much *calcareous breccia*, . . . 12'
39. Sandstone, greenish-gray, ... 10'
40. *Red shales*, ... 10'
41. Sandstone, greenish-gray, with a thin red shale near the middle containing *Archaeopteris minor*, Lx., . 55'
42. *Red shales sandy*, containing badly preserved specimens of *Dendrophycus desorii*, ... 100'
43. *Calcareous breccia* with greenish-gray sandstone at top, ... 10'
44. *Red sandstone*, ... 5'
45. Sandstone, reddish-green, ... 10'
46. *Red shale*, ... 15'
47. Sandstone, green, flaggy, ... 10'
48. *Calcareous breccia*, ... 5'
49. *Reddish-gray* sandstone, ... 6'
50. *Red shale*, sandy, ... 25'
51. Sandstone, greenish, ... 10'
52. *Red*, sandy shale and *calcareous breccia*, ... 5'

53.	Sandstone, greenish-gray,	30′
54.	*Red shale,* sandy, contains fine specimens of *Dendrophycus desorii,*	10′
55.	Sandstone, greenish-gray with many thin layers of *calcareous breccia,*	60′
56.	*Red sandy shale,*	12′
57.	Sandstone, greenish-gray, flaggy,	25′
58.	*Calcareous breccia,*	5′
59.	*Red sandy shale,*	10′
60.	Sandstone, greenish-gray,	10′
61.	*Red, shaly sandstone,*	8′
62.	Sandstone, greenish-gray quarried for flags,	40′
63.	*Red, sandy shale,*	10′
64.	Sandstone, massive, greenish-gray containing some layers of *calcareous breccia,*	45′
65.	Sandstone, greenish-gray, not so massive as last, bottom rises from L. V. R. R., with a dip of 12°–15° S. 10° E. opposite the 174th mile-post,	50

Summary of Section.

Pottsville conglomerate visible, (Nos. 1–3, inclusive,)	83′
Mauch Chunk beds, (No. 4,)	150′
Pocono beds, Nos. 5–15, inclusive,	353′
Pocono-Catskill beds, No. 16–19, inclusive,	300′
Catskill beds, Nos. 20–65, inclusive,	1231′
Total,	2117′

No. 1 is very massive and contains large ovoid quartz pebbles together with many fragments of plants. It is the lower and main massive portion of No. XII.

No. 2, *Black slate*, is the stratum from which Mr. R. D. Lacoe, of Pittston, has obtained so many *fossil plants* which have been described by Prof. Lesquereux and enumerated in a previous chapter (p. 39). The slate is quite bituminous and seems to be the equivalent of the *sub-conglomerate coal* seen in Cobb's gap, near Scranton. See G⁴, page 52

Although so near the base of No. XII as to be entirely below the pebbly portion, it should probably be included as a member of XII, since the *Flora* is much more closely related to No. XII than to that of No. XI.

This deposit of *coal* or *bituminous matter* is not always present, but is quite irregularly distributed, since it is entirely absent only a few rods north from the locality (base of Campbell's Ledge) where Mr. Lacoe obtained the plants.

This irregularity in distribution is often doubtless due to erosion by the rapid current which transported the very coarse material of the conglomerate above.

No. 3, Mr. Lacoe regards this as the true base of XII, since it is quite different lithologically from any of the genuine members of the *sub-carboniferous.*

A white sandstone of the same thickness as No. 3, was seen immediately below the equivalent of No. 2 near Nanticoke.

No. 4. I have referred these greenish-gray, sandy beds to the horizon of the *Mauch Chunk shales, No. XI*, although there is a *complete absence of red shale* at this locality. It is true that at Mauch Chunk and elsewhere there is always much gray or greenish rock in No. XI besides the characteristic *red shale.*

That the *red beds* are absent here through failure of deposition, seems proven from the fact that in passing southwest into Luzerne county, the *red beds* are seen coming in and gradually increasing in thickness by interleaving with the gray beds.

Nos. 5 to 8. These *Pocono* strata together with 30′–40′ of the basal portion of No. 4, make the great cliff which crowns the summit of the mountain in a nearly vertical wall more than 200′ high. They (Nos. 5–8) are genuine *Pocono rocks* having the yellowing-gray cast, and current bedding so common to the beds of No. X.

No. 10. A thin bed of red shale, only 10′ thick, of deep red hue and somewhat sandy, was seen at this horizon along an old road which ascends the mountain to the quarries formerly operated there.

No. 12. The Griswold's Gap conglomerate of the Wayne and Susquehanna county report (G⁵) is a very massive, grayish-white sandstone, of which some portions, especially the center and base, are filled with large quartz pebbles. The upper portion is not so pebbly; and extensive stone *quarries* were once opened in it here, on the Holgate property, several fine buildings in Wilkes-Barre, Pittston, and other towns being constructed from sandstone obtained

here. This portion has a grayish-white color, is free from iron stains, and very durable.

This rock, together with the underlying massive beds, makes a long ledge of cliffs in the gap.

Nos. 13, 14, 15. The genuine Pocono beds would seem to end with No. 15, a massive, yellowish-gray sandstone with large quartz pebbles in its basal portion, and entirely different lithologically from any of the underlying beds; in fact it seems to rest with a slight unconformity on the green shales below. The 85′ of rock under the main massive portion of the Griswold's Gap conglomerate (No. 12) at this locality may be regarded as belonging to it.

Nos. 16, 18, 19. The Pocono-Catskill beds are represented by Nos. 16–19 inclusive, a series of massive greenish-gray sandstones interstratified with only a trace of *red beds.*

No. 22 has been *quarried* quite extensively for flags, along the little stream which puts into the Susquehanna first above Coxton. The rock is bluish-green and has the typical lithological aspect of the genuine *Catskill.*

No. 24 is a very massive, current-bedded, gray sandstone, which has scattering quartz pebbles, and makes a great cliff along the hill where the little stream plunges over it to the L. V. R. R. in a cascade 50′ high.

No. 38. Much *calcareous breccia* occurs in this and it is possible that it represents the horizon of the *Cherry Ridge limestone.*

The *Cherry Ridge red shale* would then be represented by Nos. 39, 40, 41 and 42, 175′, of which 110′ are *red.*

The Honesdale sandstone group seems not to be well defined, though it is very probably represented by the 200′ of rocks in Nos. 39–55 inclusive, a series of interstratified red beds, green sandstones, and *calcareous breccias.*

Nos. 56 to 63. The Montrose red beds seem to come at the horizon included under the intervals in Nos. 56–63, or 120′ of material, of which only 40′ are *red.*

No. 64. Whether or not these identifications be correct it seems not improbable that with No. 64 we come down to rocks which represent the *New Milford sandstones* of Susquehanna and Wayne counties, *i. e.* the *Delaware river*

flag series of Pike and Monroe counties. These beds continue rising slowly northward to the vicinity of Ransom station at the northern edge of the township, when 600′-800′ of them have risen above river level, but the axis is not strong enough to bring up the Chemung which does not appear even at the crest of the *Watsontown axis* in Newton township, just north from Ransom.

Chapter VIII.

Township Geology of Luzerne.

25. Exeter township.

This is a long narrow area bordering the west bank of the Susquehanna river just across from Ransom township, and extending northward to the southern boundary of Wyoming county.

The Susquehanna river after making the breach through the Lackawannock mountain at the south-eastern corner of this township, veers to the south-west down the *Wyoming coal basin*, the northern rim of which occupies a strip about 1¼ miles wide along the southern border of Exeter. Hence *the rocks* of this township extend from the *Anthracite coal measures* down nearly to the top of the *Chemung*, where the *Watsontown (Milton) axis* crosses the Susquehanna river near the mouth of Coray's creek, or rather about one mile north from that.

The same beds then may be found in this area that have just been described from Ransom township, in Lackawanna county, on the opposite side of the Susquehanna river, and to that the reader is referred.

The wide valley of the Susquehanna after it turns to the south-west down the strike of the *Lackawanna coal basin*, in this township, is in striking contrast to its gorge-like channel through the *Catskill plateau* to the northward in Wyoming county.

This valley is filled with drift deposits to an elevation of 70′–75′ above the Susquehanna river at the highest point, and much of it seems to have been rehandled and spread out over the wide, level plain. About one mile north from the present river channel is the over-flow channel of the Sus-

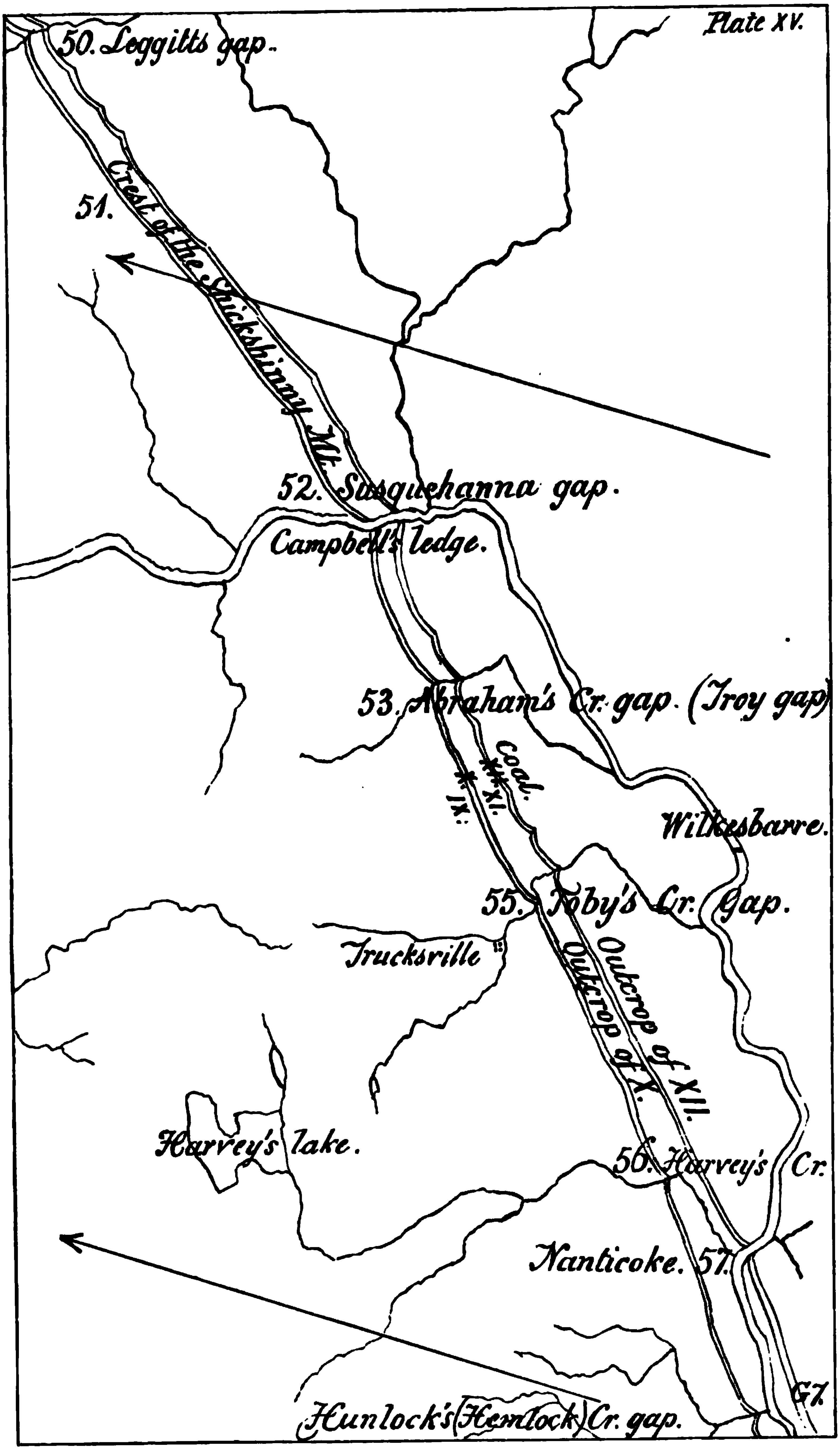
Plate XV.
50. Leggitts gap.
51.
Crest of the Shickshinny Mt.
52. Susquehanna gap.
Campbell's ledge.
53. Abraham's Cr. gap. (Troy gap)
Coal.
XI.
IX.
Wilkesbarre.
55. Toby's Cr. Gap.
Trucksville
Outcrop of XII.
Outcrop of X.
Harvey's lake.
56. Harvey's Cr.
Nanticoke. 57.
G7.
Hunlock's (Hemlock) Cr. gap.

quehanna down which its surplus waters pass in very high floods to connect with the main river near Maltby.

The buried channel which is found along this portion of the Susquehanna river, has already been fully described in a previous portion of this report. See pages 24 to 27.

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26. Kingston township.

This township adjoins Exeter on the west and also borders the north bank of the Susquehanna river.

The rocks found within this area extend from the Anthracite Coal Measures down to near the base of the Catskill, the former occupying a strip one half mile wide along the southern margin.

The conglomerates of Nos. XII and X come up from under the Anthracite Coal Measures with a sharp dip, and their upturned edges make the Lackawanna mountain which runs east and west through the township just south from its center.

Toby's creek and *Abraham's creek* cut squarely through this mountain into the Wyoming valley, when each veers westward and meanders about in the wide, drift-filled valley for two third miles before entering the Susquehanna river.

The Milton axis, in the northern portion of this township, does not bring up *Chemung beds* at any point so far as known.

The basal member of the *Pottsville conglomerate* rises above Abraham's creek near Mr. I. C. Shoemaker's on a dip of 15°-20° S. 10° E. It is quite massive and makes a cliff along the hills, as it rises rapidly to the summit of the mountain.

About one fourth mile above the forks of the road at Mr. R. R. Frear's the following section was obtained on Abraham's creek, beginning near the base of the *Catskill-Pocono beds*.

Section in the Gap of Abraham's Creek, (Fig. 53, page 144.)

1. Sandstone, massive, pebbly,	50′
2. Dark blue shales,	15′

3.	Sandstone, massive, pebbly,	15
4.	*Red shales, sandy*, (top of Catskill,)	35
5.	Sandy shales, greenish,	15
6.	Concealed,	50
7.	Sandstone, massive, greenish-gray,	25
8.	*Red shale*,	35
9.	Sandstone, greenish-gray, flaggy, (QUARRY,)	70
10.	*Red shales*,	10
		320'

The concealed interval at the top of this section, between the base of No. XII and the top of No. 1, is about 3000′ horizontal, with an average dip of 15° which would give a thickness of about 770′, which, with the 80′ of Nos. 1–3 at the top of the section, gives an interval of near 850′ for the *Sub-carboniferous Pocono-Catskill*, of which possibly 200′ should be placed in the *Mauch Chunk shale.*

No. 4. The rocks beginning with No. 4 look so much like the genuine *Catskill beds* that there would seem to be no doubt of their belonging in that series.

No. 9. A flagstone quarry in the lower half of No. 9 is operated at the roadside by Mr. E. Robbins. Very fine bluish-green flags, and also some building stone, are obtained from this horizon.

Calcareous breccia bowlders in masses 20′×20′×10′ are seen at the crossing of Abraham's creek near Mrs. C. Dailey's, and they very probably belong at the horizon of the *Cherry Ridge limestone*, which seems to be represented by a massive, green sandstone, (with much *calcareous breccia*,) which rises out of the creek near D. Flyn's, 130 rods further northward, at a calculated depth of 1500′ below the base of the *Pottsville conglomerate No. XII.*

Abraham's creek veers westward near J. W. Drake's as we ascend it, and flows along nearly on the strike of the *Catskill beds* for almost a mile.

Near Mr. S. Heft's this stream makes a cascade of 10′ over a massive, greenish-gray sandstone at an elevation of 1035′ A. T.

In the hill opposite this point there occurs an outcrop of *calcareous breccia* at an elevation of 1100′ A. T.

Along the road which leads southward across the Lacka-

wanna mountain past Mr. I. Schooley's, the following succession occurs a short distance south of Mr. Schooley's.

Section near I. Schooley's (Fig. 54, page 144.)

1.	*Red shales* and sandstones,	25′
2.	Sandstone, greenish-gray, massive, with large reddish pebbles,	25′
3.	*Red sandy shales* (Cherry Ridge),	100′

No. 2 is very probably one of the *Cherry Ridge conglomerates* since it very much resembles them lithologically, and it comes at about the right geological horizon.

The Cherry Ridge red shale would be represented by No. 3. The rocks of this section dip S. 25° E. 25°.

At the forks of the road, near Mr. W. Anderson's, a massive, pebbly, gray, current-bedded rock occurs at the base of the *Pocono-Catskill beds*, and very probably represents the *Mt. Pleasant conglomerate*, since the *Griswold's Gap bed* occurs several rods south from it near Mr. T. Moss' where its massive pebbly layers make the crest of the mountain at an elevation of 1450′ A. T. This last rock has a yellowish-white color, and its pebbles, (some of which are of dark quartz,) are large and many of them angular; it dips S. 30° E. 25°.

In the gap of Toby's creek, through the Lackawanna mountains, the base of the *Pottsville conglomerate* rises above water level at Rice's Grist mill, and in ascending the stream the following section was obtained by pacing the concealed intervals:

Section in Gap of Toby's creek (Fig. 55, page 144.)

1.	*Pottsville conglomerate*, base visible,	30′
2.	Concealed 1000′, dip 20°,	say 342′
3.	Sandstone, gray, current-bedded,	40′
4.	Sandstone, gray, with streaks of red, and some thin bands of calcareous material,	35′
5.	Sandstone, gray, current-bedded,	25′
6.	Sandstone, massive, some pebbles,	25′
7.	*Red shale*,	20′
8.	Sandstone, reddish,	5′
9.	Sandstone, gray, massive,	75′
10.	Brown sandy shales,	10′
11.	Concealed,	5′

12.	*Griswold's Gap conglomerate*, a very massive, yellowish-white, pebbly sandstone,	75′
13.	*Red shales*,	35′
14.	Sandstone, greenish-gray,	60
15.	Concealed 600′, dip 20°,	say 205′
16.	Sandstone, greenish-gray, flaggy,	40′
17.	Shales, dark, slightly bituminous,	10′
18.	Sandstone, greenish-gray, dip S. 35° E. 24°,	25′
19.	Concealed,	10′
20.	Sandstone, greenish-gray,	20′
		1057′

The *Sub-carboniferous series* is here (Nos. 2–12) about 650′ thick, since No. 12 is unquestionably the base of the *Pocono series*. Its pebbles are very numerous and large, and many of them are of *dark quartz*.

The creek flows along on the strike of this *Griswold's Gap conglomerate* for nearly one half mile above the toll-house.

No. 6 has scattered pebbles and makes a cliff along the stream at the creek crossing near Dr. Brisbin's.

Nos. 13 to 20 represent the *Pocono-Catskill beds*, and have very much of a Catskill aspect at this locality, seeming only to differ from the genuine beds of the latter by the small amount of *red shale* which they contain.

No. 17 rises out of the creek about 200 yards south from the Forest House below Trucksville; and from this on up to the crossing of Toby's creek in Trucksville, the rocks are mostly concealed, though occasionally some *red shales* and green sandstones are visible, dipping S. 35° E. 25°.

A bed of calcareous breccia, 5′–6′ thick, rises from the bed of Toby's creek, opposite the grist mill in Trucksville, and it may possibly represent the *Cherry Ridge limestone*.

Glacial striæ, trending S. 35° W., occur on a hard, greenish-gray sandstone, near Mr. P. Youngblood's, one mile north-east from Trucksville.

The Griswold's Gap conglomerate is seen at the roadside near Mr. H. Johnson's where the road descends through the gap of Toby's creek along the little stream that unites with the latter there. It is very coarse, pebbly, and apparently 75′–100′ thick, dipping S. 30°–35°, E. 25°. The pebbles are *flat* rather than ovoid, and some of them are of *dark*

quartz. Some *red shale* occurs on above the Griswold's Gap conglomerate along the road which ascends the mountain.

Barometric elevations in Kingston.

	A. T.
Level of Abraham's creek at crossing near N. Minegar's, . .	680′
Forks of road near R. R. Frear's, ...	715′
Forks of road near I. Phillips', ...	890′
Abraham's creek, here at road crossing, ...	880′
Forks of road near D. Flynn's, ...	900′
" " 244 rods north of last, ...	1025′
Creek crossing here, ...	1020′
Forks of road near S. Heft's est., ...	1060′
Abraham's creek here, ...	1030′
Forks of road near W. Sax's, ...	1175′
Run crossing at I. Schooley's, ...	1300′
Forks of road near W. Anderson's, ...	1425′
Summit of Lackawanna mountains, just south, ...	1450′
Forks of road at W. Atherholt's, near Trucksville, ...	875′

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27. *Franklin township.*

This township lies next north from Kingston, and extends to the Wyoming county line for its northern boundary. It is drained eastward into the Susquehanna river, principally through Sutton's creek.

Two lakelets, Mill and Cumming's Ponds, are situated near the northern line in what seems to have been an ancient buried valley, for a wide *Drift-covered* area, cut down 150′ below the bounding hills, connects the two lakelets. The northern one, (Mill,) which lies partly in Wyoming county, empties northward, while the other drains southward through a branch of Sutton or Coray's creek. The stream which eroded this ancient valley seems to have flowed southward from Wyoming county through this gap now filled with drift, and its surface reaching to 1175′ A. T.

The rocks of the township belong entirely to the *Catskill series*, in nearly horizontal beds, over the *Watsontown*, or more properly the *Milton axis.*

Glacial striæ going S. 32°–35° W. occur on a very hard, greenish-gray sandstone, near Mr. S. Brace's, at an eleva-

tion of 1225′ A. T. The rocks are planed off smooth, and scored with parallel grooves $\frac{1}{8}''$–$\frac{1}{2}''$ deep.

Glacial striæ are also seen a short distance south-east from the last, trending S. 35° W. 1215′ A. T.

Much Drift occurs on the summit of the hill near J. Searfass', and in it were seen a few small rounded bowlders of *gneiss* and *granite* 1″–3″ in diameter.

Barometric elevations in Franklin.

	A. T.
Mill Pond.	1150′
Summit in old valley, just south,	1190′
Cumming's Pond,	1165′
Forks of road near H. H. Mosteller's,	1190′
Outlet of Cumming's Pond near J. B. Boss',	1135′
Summit of road just south from last,	1250′
Forks of road at B. Courtright's,	1200′
" " at north line of Orange P. O.,	1125′
Cross-roads near D. Davenport's,	945′
Sutton creek here,	940′
Forks just south from J. H. Brace's,	1125′
Summit just south of by-road to J. Searfass',	1345′
Forks of road at E. Dilley's,	1275′
Next forks 125 rods south,	1145′
Forks at extreme south line of the township,	1090′

28. *Dallas township.*

This lies next west from Franklin, and has Wyoming county for its northern boundary. The southern half drains southward to the Susquehanna river through Toby's creek, but the northern half goes northward through Wyoming county.

The Milton axis passes through the southern margin of this township, and on Toby's creek brings the top of the *Chemung beds* nearly to daylight, and slightly reverses the dip, so that the *Catskill beds* which cover most of the township have a gentle dip to the north in the central portion of the same.

The Drift spreads in a thick sheet over nearly all of this area, so that nothing like a section can be obtained.

Glacial striæ were observed on a broad, bare platform of

hard, green sandstone, near Mr. N. Honeywell's, trending S. 45° W., at an elevation of 1260′ A. T. Some of the *grooves* are one inch deep and two inches wide.

Barometric elevations in Dallas.

Kunkle P.O.,	1070′
Creek here,	1060′
Forks of road near J. Rice's,	1250′
Cross roads south from A. Spencer's,	1335′
Crossing of run near J. Frantz's,	1210′
Cross roads near H. H. Honeywell's,	1225′
Forks of road next south,	1260′
Cross roads near Mrs. M. Pewterbaugh's,	1210′
Forks of road at north line of Dallas P. O.,	1115′
Creek here,	1105′
South forks of road in Dallas,	1120′

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29. Lake township.

This lies directly west from the northern portion of Dallas, and borders on Wyoming county for nearly 10 miles.

The eastern and southern portions drain southward through Harvey's creek, reaching the Susquehanna river at West Nanticoke, while the northern region sends its waters north-eastward through Wyoming county by way of Bowman's creek and its branches.

The rocks of this township belong to the *Catskill* and *Pocono beds*, the latter making the great wall of rock that forms the elevated summit of North mountain which extends through its north-western corner, while the *Catskill beds* cover all the lower country.

Harvey's lake is a long, narrow, irregularly-shaped body of water, the form of which is something like that of the letter T, and it occupies an old buried valley in the north-eastern corner of the township. The surface of the lake has an elevation of 1250′ above the sea, (Bar.), its maximum depth being 90′, (as determined by a number of soundings made by the writer,) and a general depth of 50′–75′ anywhere off its shores.

Much Drift occurs in the vicinity of the lake, and it has evidently originated from the damming up of a pre-glacial valley by *morainic débris*.

The lake is surrounded by beautiful groves, and is a very popular summer resort for Wilkes-Barre, Kingston, and other towns in the Wyoming valley to the south. There is every reason for believing that the area of the lake was once much greater than now, and that its surface has been lowered more than 100′ by the cutting down of its outlet. This is evidenced by the narrow, gorge-like character of the outlet with outcropping rocks on either side, free from Drift up to 125′ above the present level of the lake.

Vast quantities of *Drift* occur along Harvey's creek in the last two miles of its course through this township.

Barometric elevations in Lake.

	A. T.
Level of Lake Harvey,	1250′
Forks of road at Presbyterian church near outlet of last,	1300′
Harvey's creek at road-crossing here,	1220′
Forks of road at outlet school-house,	1350′

30. Lehman township.

This area lies next south from Lake, being nearly rectangular, except a narrow neck which extends north to the southern margin of Lake Harvey.

The rocks belong to the *Catskill series* except over small areas along Harvey and Pike creeks, near the southern margin, where the *Milton axis* brings the *Chemung-Catskill beds* to the surface, and possibly a small portion of the uppermost *Chemung;* though the *Drift* covers them up so completely that the outcrop cannot be seen, and hence the presence of the latter is only conjectural.

Glacial scorings go S. 50° W., on hard, greenish-gray *Catskill sandstone*, just north from Mr. T. Shaw's at an elevation of 1275′ A. T.

Great heaps of Drift are found all along Pike and Harvey's creeks, the latter of which carries the drainage off this area southward into the Susquehanna river. Bed-rock is seldom seen along either of these streams.

Barometric elevations in Lehman.

	A. T.
Cross roads at Lehman P. O.,	1340′
Forks of road next north,	1325′
Forks of road next south from Lehman P. O.,	1315′
Forks of road 309 rods south of last,	1275′
Run crossing near S. G. Howell's,	1230′
Cross roads near saw-mill at the southern edge of Lehman,	1160′
Forks of road near T. A. Brown's,	1150′
Level of Harvey's creek here below mill-dam,	1090′
Forks of road near M. Lain's store,	1075′
Level of Harvey's creek here,	1060′
Forks 656 rods south of last,	1185′

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30. Jackson township.

This small area lies just south from Lehman, and is bounded on two sides by Plymouth.

The western portion is drained southward into the Susquehanna river by Harvey's creek, while the eastern half drain through Toby's creek.

The Catskill beds make the surface rock over the entire area, except a narrow strip along the crest of the *Milton axis*, where the *Chemung-Catskill beds* are brought up, (and possibly a small area of the *Chemung*,) where the axis crosses Harvey and Toby's creeks, but as the Drift covers up everything at these localities the *Chemung rocks* were not seen.

Calcareous breccia in a massive bed rises above the level of Harvey's creek, about 100 yards below where the latter stream is joined by Simon's creek, at the southern margin of the township.

Red shale occurs immediately above this stratum, and massive, greenish-gray sandstone below. This continues on north to the forks of the creek, dipping S. 25° E. 20° ; then *red sandstone* and sandy shales begin to come up, and in passing northward toward J. B. Smith's 200′-250′ of *red beds* occasionally interstratified with greenish-gray sandstone, rise above Harvey's creek.

Barometric elevations in Jackson.

Junction of Harvey's creek with Simon's creek,	780′
Harvey's creek near J. B. Smith's,	880′
Forks of road at B. Carter's,	925′
Creek here,	920′
Forks of road near M. O. Case's,	1060′
" " at L. S. Simon's,	1135′
Simons' creek here,	1130′
Forks of road at G. Cease's,	960′
Harvey's creek here,	950′
Cross roads at C. Ransom's,	900′
Harvey's creek here,	855′
Forks of road at J. Stett's, at southern edge of Jackson,	1360′
Cross roads, one mile west of last,	1435′

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31. *Plymouth township.*

This township lies south and west from Jackson, and borders the Susquehanna river for nearly 12 miles, which flows westward in the *Wyoming coal basin* to the vicinity of Grand Tunnel P. O. where it veers toward the north-west, and cutting through the *Pottsville conglomerate* at West Nanticoke, passes out of the *Coal Measures* into the underlying *Mauch Chunk shales* and *Pocono beds* in which it flows from West Nanticoke to the western margin of the township.

The Pocono conglomerates make a bold outcrop along the line between this area and Jackson township, the summit of the mountain which they form, rising from 1250′ to 1400′ A. T.

In the vicinity of West Nanticoke the following section was obtained along the east bank of Harvey's creek:

West Nanticoke Section (*Fig. 56, page 144*).

1. *Coal*, double, with 3′-4′ of slate near center,	15′	
2. Very massive conglomeratic sandstone, current-bedded,	110′	No. 330′ XII.
3. Dark slates and *coaly shales*,	25′	
4. Concealed (soft rocks),	90′	
5. Very massive, conglomerate,	100′	
6. *Bituminous shale*, (*Campbell's Ledge*,)	5′	
7. Concealed,	5′	

8. Sandstone, green,	15′		XI.
9. Shales, drab and green,	15′		
10. Sandstone, green,	40′		
11. *Red shale*, interstratified with green,	25′		
	445′		

No. 2 is a very massive rock quite pebbly and exhibits much current-bedding. I suppose it to be identical with the *Scranton sandstone* of G⁵.

The interval, No. 3, has been explored for coal at this locality, but nothing except very *bituminous shales* seems to have been found in it.

Interval No. 4 appears to be composed of soft rocks from the topography it makes, and it may possibly contain one or two *coal streaks.*

The basal member of the *Pottsville conglomerate No. XII* is represented by No. 5, a grayish-white rock, filled with large ovoid quartz pebbles. It makes a great cliff along the mountain side.

The Campbell's Ledge black slate is represented by No. 6 of the section, which is seen for several rods under the overhanging cliff of the conglomerate. No fossil plants were observed in it here, though no especial search was made for them.

The rocks of the section below No. 7 belong to the *Mauch Chunk shale* horizon, and possess the lithological characters typical of those beds. This series possibly extends downwards for 150′–200′ below No. 11 before the top of the *Pocono* would be found.

The following section was made along the North Branch R. R., on the south side of the Susquehanna immediately opposite West Nanticoke :

Section opposite W. Nanticoke, (Fig. 57, page 144.)

1. Massive, pebbly member of the *Pottsville conglomerate*,	100′	
2. Shales, drab, sandy,	4′	
3. Black slate and *coaly shale* (*Campbell's Ledge*),	10′	
4. Sandstone, very hard, rather white, (base of No. XII,)	3′	
5. Green sandy shales, dip S. 25°, E. 30°,	10′	No. 425′ XI.
6. Sandstone, green, flagy,	100′	
7. Shale, greenish and reddish, sandy,	100′	
8. *Red shales*, sandy,	215′	
9. Sandstone, gray, very hard, silicious, *Pocono*,	30	

The above exposure at the base of XII renders it very probable that the *Campbell's Ledge black slate* should be included in No. XII, for the 3′ bed of sandstone directly below it is quite white and totally different in lithological aspect from anything usually found in No. XI. Hence it seems preferable to regard No. 4 as the true base of XII.

The beds of No. XI are quite sandy at this locality and foot up a total of 425′, thus showing a rapid increase in thickness when traced to the south-west from Pittston. No conglomerates were seen in this series here.

The 30′ sandstone, No. 9, seems to be the top of the *Pocono beds* which (rising rapidly to the north-west) make a cliff 150′ high along the crest of the mountain wall overlooking Harvey's creek from the east. In fact great cliffs of rock crop out on either side of the gorge through which the stream enters the Susquehanna.

The Catskill beds are exposed about one half mile up Harvey creek along the lower portion of its valley. Near Mr. H. Harrell's the following section was got on the right bank of the stream:

Section near Mr. H. Harrell's, (Fig. 58, page 176.)

1. Sandstone, gray, massive, pebbly,	30′
2. Shales, brown, sandy,	30′
3. Sandstone, greenish-gray,	35′
4. Shales, brown, sandy,	25′
5. *Red shales*, sandy,	10′
6. Sandstone, green, (dip 12° S. 25° E.,)	100′
7. *Red shales*, visible,	30′
	260′

The lowest bed of this section comes up above creek level near Mr. G. Row's, when a bend in the stream as we ascend it carries the course more toward the east, and all of this section dips under again except the massive, pebbly sandstone at top, which makes a cliff along the channel of the creek, and 15′–20′ above the same.

The rocks of this section seem to belong in the *Pocono-Catskill group*, except No. 7 which is the top of the genuine *Catskill.*

Just where these beds begin to dip under the stream, the

east bank of the same rises almost perpendicularly, and in descending it from the crest of the *Lackawanna mountain*, the following section was obtained:

Section ¾ mile above mouth of Harvey's creek, (Fig. 59, page 176.)

1. Sandstone, gray with some *red*,		25′	
2. Concealed,		30′	
3. Sandstone, green,		35′	
4. Sandstone, gray, makes cliff,		75′	
5. *Red shale*,		1′	
6. Concealed,		20′	
7. *Red shale*,		5′	
8. Shales, green, sandy,		10′	
9. Sandstone, gray,		5′	
10. Concealed,		35′	
11. Sandstone, very massive, pebbly, . . 35′	Griswold's		
12. Shales, greenish, sandy, ... 5′	Gap	80′	
13. Concealed, ... 15′			
14. Sandstone, massive pebbly, ... 25′	Conglomerate.		
15. Concealed,		75′	
16. Sandstone, coarse, gray,		35′	
17. Concealed,		180′	345′
18. Sandstone, pebbly at top for 5′,		55′	
19. *Red shale* to level of Harvey's creek which is here 615′ A.T.,		25′	
		691′	

No. 19 *red shale* at base of this section is the same as No. 7 at the base of the previous one, and, as already stated, is the top of the *Catskill proper*, the rocks above it belonging to the *Pocono-Catskill beds*, and if we regard them as ending with the base of No. 14, would have a thickness of 345′

The Griswold's Gap conglomerate is represented by Nos. 11–14, a mass of very coarse, grayish-white, large pebbled sandstones, which make a high cliff along the summit of the bluff which extends along Harvey's creek at this point.

The great cliff near the mouth of the stream is made by rocks just above the top of this section. They represent the upper beds of the *Pocono*, the same rocks that make the high cliffs of the Susquehanna gorge near Pittston.

In passing up Harvey's creek from the locality of the last section, its course is still eastward, and the rocks dip slowly under it until we come to ¾ mile above, where the

road crosses the stream to the east bank. Here the creek's course veering north, the rocks again begin to rise and the *Catskill beds* soon emerge from its bed on a dip of 15°–20° S. 25° E; so that at the northern line of the township the *Cherry Ridge beds* have risen above water level.

The basal member of XII, quite massive and about 100′ thick, is seen rising into the air on Poke Hollow, north from Plymouth borough, at an elevation of 950′ A. T.

The red beds of No. XI make their appearance along the road north from Connell's School-House, and continue dipping S. 25° E., 15°–20° until we come to Mr. S. Warman's, when a massive sandstone, the top of the *Pocono*, comes up at 1050′ A. T. Then after a concealed interval of 1000′ horizontal or about 250′ vertical, a massive conglomerate (Griswold's Gap) comes up and makes a cliff along the mountain at 1250′ A. T.

Still further north from the last another cliff runs along the crest of the mountain at the northern line of the township near Mr. Stett's. It is very probably the *Mt. Pleasant conglomerate*, and it carries the Lackawanna mountain up to 1450′ A. T.

Barometric elevations in Plymouth.

	A. T.
Forks of road opposite Mr. O. Snyder's,	775
" " " next west,	720′
Poke Hollow run here,	715′
Forks of road near A. Wray's,	800′
" " " at J. Stett's,	1350′
Harvey's creek at road crossing 1¾ miles above its mouth,	700′

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32. Union township.

This lies next west from Plymouth and like it borders on the Susquehanna river from the mouth of Hunlock's creek to Shickshinny, a distance of five miles.

North Shickshinny and *Hunlock's creeks* drain the township directly southward into the Susquehanna river, which flows south-westward in the *Mauch Chunk shales* along the strike of the rocks from Hunlock's creek to Shickshinny.

There, turning due south, it cuts across the western end of the Wyoming coal basin.
and they rise rapidly into the air just west from Shickshinny.*

The rocks of the township extend from the base of the *Anthracite Coal Measures* down into the top of the *Chemung*, which is brought to the surface about one mile south from the northern line of the township, by the *Watsontown axis.*

The Pocono beds make the high ridge just north from the Susquehanna river, extending from Hunlock's creek westward to the Shickshinny gap, and locally known as the *Shickshinny mountain*, but it is only the westward extension of the northern rim of the 3d Anthracite basin which in Lackawanna county is known as the Lackawannock mountain.

The basal, massive member of No. XII makes a cliff at the top of the steep bluff, which skirts the south shore of the Susquehanna river between Hunlock's creek and Shickshinny, rising to a height of 500′–600′.

In ascending Hunlock's creek from its mouth some *red shale* is seen along the road, and then at 100 rods from the R. R. station a massive, green sandstone comes up over which the stream makes several cascades 10′–25′ high, and falls about 75′ in a very short horizontal distance.

Below these green sandstones a massive, pebbly sandstone comes at about 400′ under the *Griswold's Gap conglomerate*, represents the *Mt. Pleasant Conglomerate* at the base of the *Catskill-Pocono beds.* It contains reddish quartz pebbles, and makes a cliff 30′ high around the hills just above where the road crosses Hunlock's creek, dipping S. 25° E. 20°–25°.

Drift heaps cover the valley and fill up the old channel of Hunlock's creek, north from where the road crosses it, one half mile above its mouth.

At the next crossing of Hunlock's creek, near Mr. A. Wildoner's, a massive, grayish-green sandstone comes up,

***This will be described by Mr. Ashburner in Report AA³ on the northern Anthracite coal-field.**

dipping S. 30° E. 25. It is separated from the Mt. Pleasant conglomerate above by 350′ of *red shale* and green sandstones, which are partially exposed along the road leading up the creek.

A bed of greenish-gray sandstone, dipping S. 30° E. 23°, is seen at the forks of the road near Mr. A. Coup's, one mile and a quarter north from Wildoner's.

Glacial striæ occur on *red shale* at the roadside, just north from Mr. Coup's, pointing S. 65°–75° W.; elevation 725′ A. T.

A "kame," or ridge of *Drift* material is seen at the junction of the two branches of Hunlock's creek, near Mr. W. Vanhorn's. It is about 50′ high and 300 yards long, sloping rapidly down on either side toward the level of the respective streams, and ending in a sharp point near their junction. It is clearly a deposit of *modified Drift* material formed by the checking of the currents of the two streams where they come together.

Glacial striæ, going S. 60°–65° W., occur just west from Mr. Vanhorn's at an elevation of 800′ A. T.

The Chemung beds are brought up to daylight in the vicinity of Muhlenburg village, where several pieces of *Chemung fossiliferous sandstone* were observed in the local Drift material.

At the cross-roads near W. Search's, hard greenish-gray sandstones occur, dipping S. 30° E. 20°.

Glacial striæ were seen on the rocks near Mr. C. Bear's trending S. 60° W., at an elevation of 750′ A. T.

Further south at A. Sorber's hard, greenish-gray rocks dip S. 30° E. 30°, and in them occurs much *calcareous breccia* not far from the horizon of the *Cherry Ridge limestone.*

The Watsontown axis crosses the main north branch of Shickshinny creek near where the road leading east from Town Line crosses that stream; for the *Chemung beds* are seen along the stream a few rods south still rising slowly (2°–3°) northward, and the crest of the arch would very probably be found not far from J. R. Bear's.

Chemung bowlders are scattered through the Drift as far

south as the cross-roads at B. Winan's, where hard, green *Chemung-Catskill* sandstones dip S. 15° E. 20°.

The Pocono beds occur along the road which descends Shickshinny creek through the gap in Shickshinny mountain. They descend to the level of the creek just north of the village of Shickshinny, as 200′ of gray, pebbly sandstones, alternating with buffish-brown sandy shales. The mountain is made by this massive series of sandstones; and about 400′ below them (through shales and concealed) comes another pebbly sandstone nearly 50′ thick, which possibly represents the *Mt. Pleasant conglomerate.*

Barometric elevations in Union.

	A. T.
Level of Susquehanna river at mouth of Hunlock's creek,	500′
Hunlock's creek at road crossing ¼ mile above its mouth,	610′
Hunlock's creek at second crossing above its mouth,	640′
Forks of road near G. Wildomer's,	685′
Hunlock's creek near A. Coup's,	700′
Forks of road at W. Vanhorn's,	790′
Hunlock's creek here,	785′
Forks at P. Bowman's,	1050′
" near E. Roberts',	825′
Shickshinny creek here, (E. B.,)	800′
Cross-roads at W. Search's,	825′
Forks of road at C. Bear's,	735′
" " " near A. Sorber's,	680′
" " " near J. Bear's,	630′
Shickshinny creek here,	620′

33. Ross township.

This lies directly north from Union, and extends to the Wyoming county line, meeting the latter near the south-east corner of Sullivan.

The drainage system is quite complicated; the extreme northern region sending its rainfall north-eastward through Wyoming county by way of Bowman's creek; the extreme southern portion draining directly south to the Susquehanna through Hunlock's and Harvey's creeks; while the entire central region drains westward by way of the Huntingdon branch of Big Fishing creek, into the Susquehanna in Columbia county.

The rocks belong to the *Pocono*, and *Catskill*, and *Chemung-Catskill* with possibly a small area of *Chemung* in the south-western portion of the township.

The Pocono beds make the crest of the *North mountain* which extends east and west across the northern half of the township; and they also make the wilderness country drained by Bowman's creek from the southern escarpment of the North mountain northward to the Wyoming county line.

The Catskill beds cover a large portion of the township south from the North Mountain and make the farming lands of that region.

As already stated, it is possible that a small area of *Chemung* exists in the south-western corner, but, if so, it is covered so deeply with *Drift* as to be entirely concealed.

North Pond, *South Pond*, and *Grassy Pond* are lakelets in the southern portion of the township made by the heaping up of *Drift materials* in the old valleys of Hunlock's creek, into which the lakelets now drain. *South Pond* is the largest. On the township map of the Luzerne Co. Atlas it is represented as having no outlet, but this is erroneous, since it has one southward into Hunlock's creek.

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34. Fairmount township.

This township lies west from Ross in the north-west corner of Luzerne between Wyoming and Sullivan.

The drainage is all into Big Fishing creek through Huntington creek and its tributaries, Kitchen and Pine creeks, except a small area in the extreme north-eastern portion where the head-waters of Bowman's creek rise.

The Pocono beds form the southern escarpment of the North Mountain across the northern half of this township, and also the elevated plateau that extends from that range northward into Sullivan and Wyoming counties.

The Catskill covers a belt two to two and a half miles broad immediately south from the North mountain; while the *Catskill-Chemung* and *Chemung rocks* have an outcrop

about one mile and a half broad along the southern border of the township.

Kitchen creek takes its rise in the south-eastern corner of Sullivan county on the North Mountain plateau, having as its source a small lake known as *Long Pond.* This lakelet is one mile long lacking 180′; only 100–200 yards wide; greatest depth 13′, and elevation by barometer 2200′ A. T. The basin of the pond seems to be due to the impeded drainage natural to an elevated plateau region, since I could find no evidence of *morainic débris* around its margin.

From this pond Kitchen's creek meanders slowly southward with gentle fall on the top of the nearly horizontal *Pocono conglomerates.* But after entering this township for about one mile, it passes over the southern escarpment of the *Griswold's Gap conglomerate*, in leaving *Dodson pond*, and then begins a rapid descent of the North mountain slope through a narrow cañon, interrupted by frequent cascades 25′–100′ high.

In descending this stream from Dodson pond to the east and west road along the base of North mountain, the following succession was observed:

Section along Kitchen creek descending North mountain (Fig. 60, page 176.)

1.	*Griswold Gap massive conglomerate,* visible		30′	
2.	Concealed and greenish-gray sandstone,	250′		Catskill-Pocono.
3.	Sandstone, massive, gray, makes cascades,	85′		
4.	Concealed,	25′		
5.	Sandstone, gray, massive, coarse makes cascade,	90′	460′	
6.	Concealed,	30′		
7.	Sandstone, massive gray, makes cascade, and is the base of *transition beds IX–X,*	30′		
8.	Concealed,		15′	
9.	Sandstone, greenish-gray, makes cascade,		25′	
10.	*Red shale,*		10′	
11.	Concealed,		15′	
12.	Sandstone, greenish-gray, makes cascade,		75′	
13.	*Red shale,*		10′	
14.	Concealed,		30′	
15.	Sandstone, greenish-gray, makes falls 35′ high,		60′	
16.	*Red shale,*		25′	
17.	Sandstone, greenish-gray, (cascade,)		15′	
18.	*Red shale,*		20′	
19.	Concealed,		5′	

20.	Sandstone, greenish gray,	20′
21.	*Red shale,*	20′
22.	Sandstone, massive, visible	15′
23.	Concealed to road crossing of Kitchen creek, horizontal distance ¾ mile, vertical by Bar. 110′, but taking a northward dip of 4°–5° into account would increase the concealed interval to about (mostly soft rocks,)	400′
24.	Sandstone, hard, greenish-gray makes head of falls at road,	20′
25.	*Red shale,*	10′
26.	Sandstone to foot of falls 1170′ A. T.,	20′
		1300′

No. 1. *The Griswold's Gap conglomerate* is a very massive rock with large and mostly angular pebbles of white quartz. The entire bed is probably much thicker than the portion here seen, making a great cliff around the northern border of *Dodson Pond* with its base at an elevation of 2125′ A. T. It is this bed which makes the high cliffs along the southern crest of *North Mountain*,* and to its massiveness is due the great elevation of that range. The extreme southern crest of the North Mountain is nearly one half mile south from Dodson pond, so that the *north dip* of 4°–5° carries this bed up nearly 150′ higher than at Dodson pond, making the crest say 2275′ A. T.

The transition beds of IX–X have here a thickness of 460′, as measured by barometer; but as all of the intervals were taken nearly vertically the total thickness can not be much affected by the gentle northward dip, except to increase it slightly, but this could not make it more than 20′ or 25′ greater.

It is possible that the *transition series* should end with No. 5, thus making it 400′ thick instead of 460′ as given in the section.

A bed of red shale belongs near the top of the *transition beds*, but its horizon was concealed at this locality.

The sandstones in the lower half of this *Catskill-Pocono series* are very massive, and they weather to a yellowish-gray color where the water of Kitchen's creek splashes over them, thus taking on a decided *Pocono cast;* but elsewhere along the mountain, when not exposed to running

* A continuation of the Allegheny Mountain of Middle Pennsylvania.

water, these beds have a greenish-gray aspect, very much resembling the sandstones in the genuine *Catskill.*

No. 3 makes a nearly vertical cascade 75′ high, while the water washes over No. 5 in a constant succession of falls 15′–25′ high.

The Mt. Pleasant red shales are represented in the section below the *Transition series;* but where they should end it would be impossible to decide, since the interval contains so much sandstone at this locality. But it seems probable that No. 23 is not far from the top of the *Cherry Ridge group*, the rest of which together with its *calcareous breccia* is concealed in the interval, No. 23.

Nos. 24–26 possibly represent a portion of the *Honesdale sandstone group*, since they come in the section about where we should expect that *series* of rocks. These beds make what is known as the *Kitchen creek falls*, a wild and romantic gorge much visited by pleasure parties in summer. The stream first makes a vertical plunge of 18′ over the very hard top rock into a deep narrow gorge which splits into two below, and then descends into a wide amphitheatre, which, suddenly contracting, the stream passes out through a dark, narrow glen, falling into a second basin 30′ below, from which it descends to a third by a vertical fall of 10′, making the entire descent from the top to the foot of the last, 50′.

The rush and roar of the stream when, in a swollen condition, it dashes through these narrow cavernous channels are said to be grand in the extreme.

The following section was obtained about one mile west from the last, in descending North mountain along the pike which passes northward into Sullivan county:

Section along North mountain pike, (Fig. 61, page 176.)

1. *Griswold's Gap massive conglomerate,* . . . . . visible	25′
2. Sandstone, massive, coarse, grayish-white, ...	35′
3. Sandstone and concealed, ...	40′
4. *Red shale,*	30′
5. Sandstone, gray and concealed, ...	85′
6. Sandstones, gray and greenish-gray, a very massive bed at base, representing the bottom member of the *Transition series,*	275′

7. Green sandstones and *red shales*, ...		300′
8. Massive sandstone, ...	visible	20′
9. Concealed to road in front of Hacker's hotel (1885′ A. T.,)		250′
		1060′

No. 1 makes the crest of the mountain just north from where the by-road turns off to Dodson pond, the elevation being 2260′ A. T., the highest point on the Berwick pike. It makes a bold cliff along the mountain, and dips north under the Sullivan county plateau.

No. 2. The coarse, grayish-white sandstone directly below the conglomerate should very probably be classed with the Pocono rocks as a portion of the *Griswold's Gap conglomerate;* at any rate its lithological characters would ally it decidedly with the true *Pocono beds.* It crops out on the pike just where the by-road turns off to Dodson pond.

The Transition beds (*IX–X*) are represented by Nos. 3–6 inclusive, and they foot up a thickness of 430′, nearly the same as that (460′) given for these beds in the previous section on Kitchen creek.

A bed of dark red sandy shale 40′ thick occurs near the top of this group, and it makes a conspicuous band of red across the pike just below the summit of North Mountain from which fact the locality has long been known as "*The Red Rock.*"

The sandstones in No. 6 have mostly a greenish-gray cast; but are less massive and destitute of the buffish-gray color so well marked on Kitchen creek.

Red shale seems to make up more than half of No. 7.

Vast heaps of *Drift* are strewn over the surface of this township, especially along the foot slopes of the North Mountain and one half mile south from the same.

Glacial striæ were seen on a hard, green sandstone along the hill road which descends Kitchen creek just south from the cross-roads near Downing's School House; they trend S. 70° W. at 1175′ A. T., the rocks there dipping 10°–12° N. 20° W.

About two miles north from this *striæ* occur at the roadside near Mr. J. Marshall's, pointing S. 80° W. at 1225′ A. T.

The Chemung beds are brought up a short distance south

from Downing's School House, and extend to the southern line of the township, the *Watsontown axis* having rapidly increased in magnitude in its westward extension through Ross. This is also shown by the increased north dips; for at the eastern border of Luzerne there is scarcely any north dip of the rocks north from this axis, while here in Fairmont at the western line of the county, the dip is 10°-15°.

The Chemung beds are first seen on the Berwick pike, as we pass south from Red Rock P. O., near Mr. R. Gearheart's where they dip northward under the *Chemung-Catskill* at the rate of about 13°.

Barometric elevations in Fairmount.

	A. T.
Berwick pike at Long Pond Hotel,	2250'
Level of Long Pond,	2200'
" " Dodson Pond,	2125'
Berwick pike at by road just north of Luzerne county line,	2190'
" " on summit of N. mountain,	2260'
" " at road to Dodson's pond,	2220'
" " in front of J. Hacker's hotel,	1385'
" " at A. Fredley's,	1325'
Forks of road 300 rods east of last,	1290'
Kitchen creek at road crossing next east,	1220'
" " at head of great cascade, one fourth mile below Dodson's pond,	1930'
Berwick pike at forks near S. H. New's,	1225'
" " at forks near J. Headden's,	1150
" " near J. R. Potters',	1125'
" " at forks of road near J. Buckalew's,	1180'
" " at cross-roads in Fairmont Springs,	1180'
" " at forks of road near R. Gearheart's,	1110'
" " at cross-roads near S. Lateen's,	1235'
" " at forks of road next south,	1205'
" " at forks of road near S. Callender's,	1150'
" " at forks next south,	975'
" " at creek crossing,	940'
" " at forks of road near P. Ipher's,	990'
" " at forks near southern line of township,	985'
Forks of road near J. Marshall's,	1225'
Cross-roads at church near J. Moss's	1240'
Forks of road near M. F. Moss's,	1175'
Cross-roads near J. Downing's,	1260'
Forks of road near E. Santee's,	1160'
" " near E. B. Myer's,	900'
Cross-roads next south at Mrs. Stewart's,	830'

35. Huntingdon township.

This lies directly south from Fairmount township, and like it has Columbia county for its western boundary. *Huntingdon creek* flows through it from the north nearly to its southern border, and then turning westward carries the rain-fall of the township into Big Fishing creek in Columbia county.

The rocks exposed in this area belong in the series between the *Pocono* and *Chemung*, the latter covering the northern half of the township.

The upturned (to the north) edges of the *Pocono beds* make the *Huntingdon mountain* along the extreme southern border, while the *Catskill rocks* form a broad band of *red* interstratified with green sandstones across the southern half of the township.

The Watsontown axis crosses Huntingdon creek just north from Hublerville, since at the paper-mill, one half mile north from that village, *Chemung rocks* occur in cliffs along the stream with a gentle (1°–2°) northward dip. It is possible, however, that this is a *local undulation*, and that the real axis is further south.

Drift fills the valleys of the streams and covers the hills in this township with such a thick coating of débris that the rocks are seldom exposed, hence no sections could be obtained. I have some doubt whether or not the *Ice sheet* covered the summit of Huntingdon mountains since no *striated bowlders* or other evidence of its presence were seen. However, some rounded bowlders were found only 50′ below the summit, at 1450′ A. T., and it is very possible that their seeming absence from the very crest is not conclusive, though further west this mountain was certainly not covered by the ice.

Barometric elevations in Huntingdon.

	A. T.
Summit of Huntingdon mountain on road leading south into Columbia county,	1500
Huntingdon mountain on road next east at the Salem township line,	1390′
Cross-roads near J. McDaniel's,	975′

Forks of road near N. Balliet's,	890'
" " " near J. W. Davenport's,	840'
Huntingdon creek at crossing near R. Hoyt's,	700'
Forks of road next north,	760'
Forks of road at School-House, 62 rods north of last,	750'
Run at crossing next east,	715
Forks of road at J. Harrison's,	735'
" " " near T. Larned's,	740'
Huntingdon creek here,	720'
Forks of road near S. F. Monroe's,	775'
Hublerville,	775'
Cross-roads at J. B. Hahn's,	800'
Huntingdon creek at crossing below Koon's paper-mill,	760'
By-road at W. Beishen's,	850'
Forks of road just south from E. Callender's,	900'
Cross-roads just north from J. S. Hice's,	930'
Cross-roads near S. F. Headley's,	795'
Huntingdon creek at road crossing next north,	785'
Cross-roads near M. T. Patterson's,	810'
Forks of road at northern line of township near Mrs. Stewart's,	830'
Cross-roads in Cambria P. O.,	1015'
Forks at township line next north,	985'
Creek at crossing south of Cambria,	930'
Forks of road near Mrs. Doty's,	935'
Cross-roads next south, (123 rods,)	950'
" in New Columbus,	1175'
Forks of road next south, (110 rods,)	1125'
Forks of road near south-eastern corner of the township,	700'
" " " next east,	725'
" " " at W. S. Chapin's,	725'
" " " at P. Franklin's,	730'

36. Salem township.

This township lies next south from Huntington, and extends to the Susquehanna river which encloses it on the east and south, while Columbia county forms its western boundary.

The northern part is drained by *Little Shickshinny* creek which flows eastward down the fast narrowing trough of the Wyoming Coal basin, reaching the Susquehanna river at the northern line of the township. The rest of this area is drained by small streams which rise on the southern slope of *Lee's Mountain* and empty directly into the Susquehanna river.

The river, after flowing along the northern margin of the Lackawanna coal basin from Nanticoke to Shickshinny at the northern line of this township, turns abruptly southward, cutting squarely across the rapidly vanishing *basin*, and continuing about 5° east of south cuts through the upturned beds of XI, X, IX, and the most of VIII. Here encountering the soft rocks at the bottom of the latter series, near the mouth of Wapwallopen creek six miles south from Shickshinny, it veers westward and follows the *strike* of the *Hamilton beds.*

The rocks of this township extend from the basal beds of the *Coal Measures*, down to the top of *No. VI*, which, covered up by Drift heaps, is concealed from view, though certainly present on the crest of the Berwick axis where it enters this township from Columbia county.

The following section was made along the D. L. & W. R. R. in passing from Shickshinny southward:

Section along D. L. & W. R. R. south from Shickshinny, (Fig. 62, page 176.)

1. Massive conglomerate, base of *Pottsville*, visible,	50′
2. Concealed,	50′
3. Sandstone, green, pebbly,	40′
4. Shaly sandstones, green and reddish,	100′
5. Sandstone, greenish-gray, pebbly,	40′
6. *Red shale*,	700′
7. Concealed,	500′
8. Massive conglomerate, *Pocono*, visible in R. R. cut one mile below Shickshinny,	150′
	1630′

The intervals 6 and 7 were calculated by measuring the horizontal distance along the R. R. (which passes squarely across the strike) and observing the dip (which varies from 35°–50°) as often as possible. It cannot be very far from the true thickness; and as the *Mauch Chunk beds* begin with No. 2 and end near the middle of No. 7, the section shows that series to be 1000′–1200′ thick on the southern slope of the Lackawanna syncline; certainly not much less than the former figure, nor greater than the latter. This result is quite surprising from the fact that on the north

side of this syncline, not two miles distant, the *Mauch Chunk beds* are scarcely half so thick.

No. 8 stands at an angle of 65° dipping N. 10° W. and makes a mountain on either side of the river. It is a buff-fish-gray, coarse conglomerate, and is completely exposed in a cut where the Bloomsburg Division of the D. L. & W. R. R. passes through it.

The Pocono beds extend up into the concealed interval, No. 7, and also down into the beds underlying No. 8, but not very far in the latter direction, since the entire thickness of the *Pocono* here is less than 500′.

The Pocono conglomerates make two mountain ridges along the northern portion of this township, forming the two converging rims of the Lackawanna basin. The northern is known locally as *Huntingdon mountain*, while the southern, one to one and a half miles distant, is called *Lee's mountain.* The former is the westward extension of the *Lackawanna mountain*, and the latter of the *Wyoming mountain.*

The Mauch Chunk shale beds occupy, or rather once did occupy, the intervening syncline, for the West Branch of Shickshinny creek flows down this basin, and has excavated the *Mauch Chunk beds* entirely from the north and south dipping walls of Pocono, and largely from the bottom of the syncline. A wide (½ to ¾ mile) and deeply drift covered valley now extends along West Shickshinny creek completely concealing all traces of these *No. XI beds.*

Huntington mountain extends along the extreme northern border of the township, rising gradually toward the west until it reaches an elevation of 1450′—1500′ A. T., at its extreme western line.

Lee's mountain is somewhat lower, and does not reach an elevation greater than 1350′ at any point measured.

The general topography of this township exhibits in a striking degree the effect of hard and soft rocks in determining surface configuration: the *soft Hamilton beds* extend in a belt 1¼–1½ miles wide along the Susquehanna river; and here a valley of equal width, not rising much higher than 650′ A. T., and usually covered with modified

Drift, is found. Next northward comes the *Chemung rocks*, whose superior hardness makes a high and bold ridge, rising to 900′–1000′ A. T. Then the *Catskill beds* spread northward in a broad valley, usually made irregular by erosion, but having a general elevation of 800′–900′ A. T., from whose northern edge the slope is almost precipitous up to the summit of Lee's mountain, capped with the Pocono at 1350′ A. T.

The Hamilton beds are almost constantly covered up in this township by the terrace deposits except in road cuttings and other excavations. Wherever seen (as in the R. R. cuttings near Hick's Ferry and Beach Haven,) they consist of ashen and dark-gray colored slates and shales dipping northward 35°–40°, and often cleaving at a high angle (55°–60°) to the south.

The Hamilton beds dip under *Seeley's run*, (which puts into the Susquehanna river from the north at Beach Haven), near the cross-roads at Mr. D. Hill's, one mile and a half north from the river.

The Chemung rocks make a belt not quite one mile broad across the township, but their edges are covered up by terrace deposits so that no detailed measurements could be made. They consist, however, of hard, dark, olive beds in the lower half, with bluish-green layers predominating above, and a very coarse grayish-white sandstone with small pebbles near the top.

The Catskill outcrop is about one mile and a quarter broad, and sometimes a mile and a half, but its rocks are almost constantly buried under heaps of *Drift material* in the broad valley which trends along the southern slope of Lee's mountain; so that no details respecting the different members could be obtained in this township; though its topography would warrant the conclusion that it contains a considerable thickness of soft material.

Three well marked terraces occur along the Susquehanna river in this township and are all present at Beach Haven; *the first* makes the present flood plain of the river and its top comes 30′ above low water or 510′ A. T.: *the second* rises as a narrow shelf to the level of the R. R. at Beach

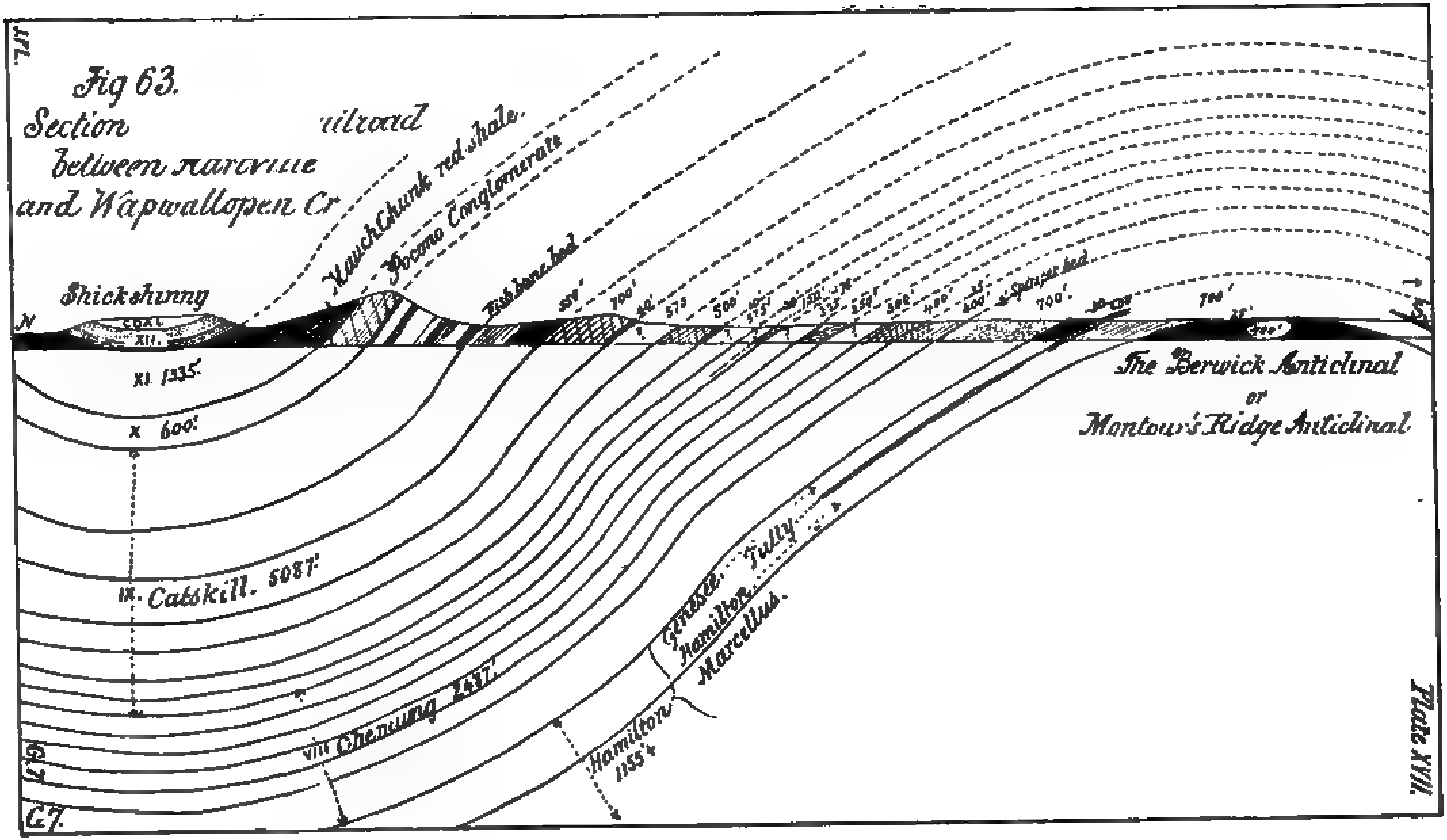
Fig 63.
Section
between Harveville
and Wapwallopen Cr
ilroad
Mauch Chunk red shale.
Pocono Conglomerate
Fish bone bed
Spirifer bed
Shickshinny
COAL
XII.
XI. 1335'
X 600'
IX. Catskill. 5087'
VIII Chemung 2437'
Genesee
Tully
Hamilton
Marcellus.
Hamilton
1155'+
The Berwick Anticlinal
or
Montour's Ridge Anticlinal.
N
S
Plate XVII.
J.P.L.
G.7.

Haven or 530′ A. T. From this the slope is almost precipitous up over a bank of rounded bowlders to a broad and nearly level expanse at 650′ A. T., marking the top of the *3d terrace.*

Many small rounded bowlders of *gneiss* and *granite*, none of which are more than three inches in diameter, occur in the material which makes up these *terrace deposits*, but these *crystalline bowlders* were not observed above the 3d terrace in any portion of the township.

The Northern ice sheet seems to have flowed over the crest of Lee's mountain at an elevation of 1350′ A. T., for many huge bowlders of the *Pottsville conglomerate*, weighing several tons, are seen on the crest and upper flanks of that mountain much further west than that formation extends.

Barometric elevations in Salem.

	A. T.
West Br. of Shickshinny at road crossing near Stackhouse's Saw-Mill,	930′
Forks of road at Dodson's School House,	1000′
Summit of Huntington Mountain on road leading north,	1450′
W. Shickshinny creek at road crossing south of J. B. Dodson's,	980′
Forks of road on Lee's Mountain 390 rods from J.B.Dodson's,	1330′
Summit of Lee's Mt. on road leading south from last,	1350′
Cross-roads at W. Master's,	890′
Forks of road at J. Walton's,	840′
Susquehanna river at Shickshinny,	495′
" " Hick's Ferry,	485′
" " Beach Haven,	480′
Forks of road 247 rods north of Beach Haven,	650′
Cross-roads near D. Hill's,	700′
Seeley's run just west of last,	670′
" " at crossing above L. Maharter's,	740′
Forks of road just south from A. Seeley's,	800′

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37. Hollenback township.

This is a long, narrow area lying east and south from the Susquehanna river opposite Salem, and my observations in it were confined to the measurement of a section along the recently constructed North Branch R. R. along the river.

The river cuts square across the strike of the rocks for

about four miles. As the dip is rapid (35°–65°) to the north all the way, the column of rocks cut through extends from the *Coal Measures* down nearly to the base of the *Hamilton beds* as shown in the following section obtained along the North Branch R. R. between Hartville (opposite Shickshinny) and the mouth of Wapwallopen creek:

Section along North Branch R. R. from Hartville to Wapwallopen, (Fig. 63, page 194.)

	A. T.
1. Basal member of No. XII, very massive, coarse and pebbly,	——
2. Concealed,	10'
3. Shales, drab and blue,	20'
4. Sandstone, green, flaggy,	15'
5. Sandstone, massive, coarse, grayish-green,	20'
6. *Red shale*, sandy,	10'
7. Sandstone, coarse, grayish-white,	10'
8. *Red and green shales*, visible,	50'
9. Concealed across valley, horizontal distance 2500', no rocks whatever visible, but they are the *Mauch Chunk beds*, and the dip cannot be less than 30', since on the opposite side of the river in Salem nothing less than 35° was noted in these beds, thickness about	1200'
10. *Pocono conglomerate*, very massive, coarse, grayish-white beds with a tinge of yellow, dipping N. 10° W. 65°–75°, thickness about	600'
11. *Red shale*, visible, (top of Catskill,)	10'
12. Mostly concealed,	250'
13. Sandstone, greenish-gray, massive,	50'
14. Concealed to a point opposite Riverside Hotel,	500'
15. Concealed with showing of *red shale*,	650'
16. Sandstone, greenish-gray,	35'
17. Concealed,	250'
18. Red and green sandy beds, dip 40°–42°,	100'
19. *Fish-bone bed*,	2'
20. Sandy beds, flaggy, green,	30'
21. Shales, greenish,	10'
22. Concealed,	100'
23. Sandstone, greenish-gray,	40'
24. Concealed,	200'
25. Sandstone, massive, greenish-gray, dip 80°–85°,	140'
26. *Red shales*, sandy, dip 45°–50°,	350'
27. Sandstones, grayish-green, current-bedded, much of it massive, dip 40°–45°,	700'
28. *Red shales*, sandy,	40'
29. Concealed to little run 174 rods north of A. Boyd's, dip 40°–45°,	575'

30.	Sandstone, greenish-gray, alternating with a few thin, sandy *red beds*, the sandstones current-bedded, dip 40°–45°,	500′
31.	*Red shale*, visible,	10′
32.	Concealed,	375′
33.	Shales, olive with *Spirifera disjuncta*,	20′
34.	Concealed, (Bottom of Catskill,)	150′
35.	Sandstone, flaggy, grayish-green, no fossils seen, making cliffs along the R. R. to little stream near A. Boyd's, dipping N. 10° W. 40°–43°,	75
36.	Concealed spaces alternating with olive shales and bluish-gray sandy flags,	325′
37.	Olive-green sandy shales, (*Stony Brook beds* at (p,) full of *Spirifera disjuncta*, *S. mesocostalis*, *Leiorhynchus*, *mesocostale*, *Productella hirsuta*, and many other forms; many crinoidal fragments near base,	250′
38.	Concealed,	300′
39.	Very hard, gray, and olive-green sandy layers, make cliffs along the R. R., and are almost non-fossiliferous,	400′
40.	Concealed,	35′
41.	Hard, sandy beds of bluish-green, or very dark olive cast, make cliffs along R. R., and contain scattering fossils of the genera *Pterinea*, *Nucula*, *Nuculana*, *Spirifera*, *Leiorhynchus*, and many other forms, dip 25°–30°,	400′
42.	*Spirifer bed*,	2′
43.	Bluish-green sandy beds, very few fossils to *base of the Chemung beds*, 150 yards north from J. Fenstermacher's, dip 25°–30°,	700′
44.	*Genesee slate*, dark-blue shales finely laminated, visible,	30′
45.	Concealed (valley) including about 200′ of *Genesee*, the *Tully limestone*, and a portion of the underlying Hamilton,	700′
46.	Shales, black, (*Marcellus*), dipping N. 10° W. 35°, visible,	25′
47.	Concealed (*Marcellus*) to middle of R. R. bridge across Little Wapwallopen creek, and to near the crest of the Berwick axis, about	400′

This section may be summarized as follows:

Pottsville conglomerate.	
Mauch Chunk shales, (Nos. 2–9 inclusive,)	1335′
Pocono, (No. X,)	600′
Catskill and *transition beds*, (Nos. 11–34 inclusive,)	5087′
Chemung, (Nos. 35–43 inclusive,)	2487′
Hamilton, (Nos. 44–47 inclusive,)	1155′
Total thickness of rocks,	10664′

The thickness above given may be regarded as practically accurate, with the exception of the *Mauch Chunk* and *Hamilton* intervals which are uncertain to a considerable

extent since each consists largely of soft rocks; and as they are nearly all concealed, one cannot rely on constancy of dip, for that is variable in soft rocks.

In the *Catskill* measurement (5087') are included all of the *Pocono-Catskill transition beds*, and also the *Catskill-Chemung series*.

The Catskill was not seen in sufficient detail to warrant any certain identifications of its various members with those of Wayne and Susquehanna counties, but it seems very probable that the *350' red shale* in No. 26 represents the *Montrose red beds*.

No fossils were observed in the small exposures of the *Genesee* and *Marcellus beds* seen in this section.

The Berwick (or *Montour*) *axis* crosses the river not far below the mouth of Little Wapwallopen creek, probably about half way between it and the mouth of Big Wapwallopen creek, or more accurately at the island in the Susquehanna river, one half mile below the mouth of the Little Wapwallopen.

The strata are seen coming down to the south-east at a rapid rate (40°), just east from Wapwallopen village (near mouth of the big creek,) while the hard rocks of the lower *Chemung* make a great cliff 500'-600' above the level of the river.

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38. Nescopec township.

This lies next west from the southern end of Hollenback, having the Susquehanna river for its northern boundary, and Columbia county for its western.

Nescopec creek, its principal stream, enters the township from the south through a narrow gap cut squarely through the Nescopec mountain, about 800' high.

The geology of this area is quite simple, since it lies entirely on the south slope of the *Montour* axis; thus *the Hamilton beds* floor the Susquehanna river, and make a narrow fringe of outcrop along the southern bank; then come the *Tully limestone* and *Genesee slate* with rapid

southward dip making a narrow outcrop under the great piles of terrace deposits which form a high bluff overlooking the river for three or four miles below the mouth of Wapwallopen creek.

Back from the terrace deposits runs the *Chemung ridge*, and then a wide plain of *Catskill rocks* extends southward to the base of the Nescopec mountain whose summit is made by the hard rocks of the *Pocono*, dipping rapidly southward.

The Hamilton beds are seen opposite Beach Haven extending from the north shore of the Susquehanna more than three fourths of the distance across the stream, and making rapids for nearly a mile.

The irregular masses of black-looking beds which rise 3′–4′ above the bed of the river are always bare during low water stages of the river. They dip rapidly to the south.

Near the Nescopec shore these beds break away, however, and the river there flows upon a bed of trash ; while a great bluff of modified *Drift* rises precipitously along its banks to an elevation of 175′ or 655′ A. T., and extends at this level about one third mile back from the Susquehanna ; being the same *terrace formation* as that noted on the opposite side of the river in Salem township. It is a perfect mass of rounded bowlders, sand, and river silt.

It is worthy of remark, as bearing on the origin of these immense deposits of Drift trash, that the Susquehanna receives a large tributary (Big Wapwallopen,) at the eastern end of this township, only two miles above Beach Haven, and that this great terrace deposit begins there.

The pre-glacial channel of the Susquehanna river was under this terrace in the vicinity of Beach Haven.

Chemung rocks are seen at the roadside just south from W. Thrash's, dipping S. 10° E. 30°.

Rounded bowlders occur on south from this to the summit of the hills at 850′ A. T.

Red rocks of the *transition beds VIII-IX* occur at the forks of the road near A. Santee's, dipping S. 10° E. from 40° to 45°.

Catskill beds are exposed along Nescopeck creek oppo-

site J. Driesbach's mill, consisting of alternate green sandstones and *red shales* all dipping S. 10° E. 45°. These continue on northward to the mouth of Summerville creek where the *Chemung-Catskill* rocks rise from the bed of the Nescopec.

An impure limestone was seen along the south shore of Nescopec creek just north from P. Good's. It rests on olive green shale and is very silicious.

As we pass north from this toward the Susquehanna river, the *Chemung beds* come up and extend to the forks of the road at Evan's grist-mill, on Nescopec creek, where the *bluish-black shales of the Genesee* crop out along the stream.

The Tulley limestone is partially exposed at the forks of the road just east from Evan's mill, where its dull gray and drab colored beds dip S. 10° E. 40°, one half mile south from the Susquehanna river. Across this space a wide plain covered with fine Drift gravels extends at an elevation of 525′ A. T. or 50′ above low water in the Susquehanna river. This is the *second terrace*, and its summit sometimes falls off to 40′–45′ above the river.

Barometric elevations in Nescopec.

	A. T.
Cross-roads at W. Thrash's,	685′
" " A. Santee's,	840′
Summerville creek just north,	740′
Nescopec creek at southern line of the township in Nescopec mt. gap,	620′
Forks of road just west of Nescopec creek and 58 rods south from southern line,	785′
Forks of road 108 rods next south,	780′
" " " 216 rods east of last,	855′
Nescopec creek at Dreisbach's mill,	545′
Forks of road 54 rods east from Evan's grist-mill,	525′
Nescopec village,	515′
Susquehanna river at mouth of Nescopec's creek,	475′

CHAPTER IX.

Township geology of Columbia.

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39. Sugar Loaf township.

This occupies the extreme north-eastern corner of Columbia, next to Sullivan and Luzerne.

It is drained entirely by Big Fishing creek, which cutting through the North mountain escarpment, at the northern line of the county, in two streams (the East and West Branches) flows southward entirely through the *township.*

The rocks of this area belong to the *Catskill* with the exception of a narrow belt of *Pocono* which caps the summit of North mountain.

Drift heaps of great thickness cover a large portion of it, especially along the southern foot slope of the North mountain; in fact the surface is so littered up with large bowlders of *Pocono* and *Catskill rocks*, commingled with the finer materials of the Drift that no outcropping beds can be seen over large districts.

Glacial striæ trending *due south*, were seen along the road which passes westward from W. Steven's toward the East Branch of Big Fishing creek. They are on a hard, greenish-gray sandstone of the *Catskill* just east from the crossing of the East Branch, and at an elevation of 975′ A. T. The sandstone dips northward about 6°, and is polished quite smooth the *Ice scratches* being very numerous, but none of them deeper than one fourth inch.

A wide plain covered with small gravels and cobble stones, spreads out at the junction of the East and West Branches of Fishing creek, in the vicinity of Hess's school-house. During the *Flooded river epoch* the junction of these two

streams was just north from the school-house and at that time a broad sheet of running water covered all this level space transporting the small rounded bowlders and gravel from the North mountain plateau and depositing them about the junction of the two streams where with a decreased descent the velocity was suddenly checked.

This plain is now, however, about 30′ above the level of the present streams; and they flow southward for nearly two miles before uniting, being kept asunder by a long, narrow neck of these deposits.

Barometric elevations in Sugar Loaf.

	A. T.
Forks of road at Cole's Creek church,	900′
" " " " P. O.,	875′
Level of Fishing creek here,	850′
Forks of road at D. Lewis',	925′
Cole's creek at crossing next north,	900′
Cross-roads at A. W. Kline's,	1000′
Cole's creek at Davis's mill,	950
School-house just north from Geo. Sutliff's,	1275′
Next forks to the north at O. Park's,	1225′
Cole's creek, just east from E. Hughes',	970′
Cross-roads west from E. S. Fritz's,	1205′
East Fishing creek at road-crossing next west from W. Steven's,	925′
Forks of road at Mrs. Sutlift's,	955′
West Fishing creek here,	945′
Forks of road at Hess's school-house,	985′

40. *Benton township.*

This township lies south of Sugar Loaf, and adjoins Luzerne.

It is drained by Big Fishing creek, which enters from the north and flows southward entirely through it.

The rocks are *Catskill* and *Chemung*, the former making a narrow belt (about one mile wide) along the northern border of the township, while the *transition* and *Chemung* spread south-ward over the rest of its surface.

All of the beds dip northward at the rate of 8°–10°.

No ice scratches were observed in this township, but

many great heaps of bowlder beds occur, and some of them are possibly true *Drift beds.*

A broad terrace of the *Flooded river material* is seen in the vicinity of Benton village, and northward from there to Cole's Mills, stretching from Big Fishing westward to *West creek.* The junction of these two streams was just south of Cole's Mills during the Flooded river epoch, when swollen to the magnitude of rivers by the melting Glacial Ice of the North Mountain plateau, they descended in rapid torrents, freighted with mud and gravel, and pushing the larger bowlders along their beds. But spreading out in the wide valley at the junction of the two streams, the velocity was checked and the bowlder bed deposited which now extends from near Cole's Mills southward for two miles, with an average breadth of ⅜ mile, to the present junction of the streams below Benton village.

The two streams (Fishing and West creeks) now flow along the outer margin of this deposit which spreads in an almost level plain between them at an elevation of 15′–20′ above each, and about 800′ A. T.

Chemung olive-green beds were observed at the roadside near P. Appleman's just south from Benton, dipping N. 10° W. 9°–10°. The genuine *Chemung beds* do not extend very far north from the southern line of the township. Then the *transition rocks* (VIII–IX) come down and form the surface beds northward to the edge of the *Catskill;* which comes down to water level on Fishing creek just north from Cole's Mills, where *deep red shales* and greenish-gray, current-bedded sandstones are seen dipping northward at the rate of 10°–20°.

A high bluff of very coarse material comes suddenly in near the northern line of this township on Fishing creek. It is composed largely of bowlders 1′–3′ in diameter, and extends several rods eastward from the stream at an elevation of 50′–60′ above the same. It is very possibly the *Terminal Moraine* of the *Ice tongue* which descended Fishing creek and made the scratches running due south seen in Sugar Loaf township.

Barometric elevations in Benton.

	A. T.
Forks of road at southern edge of township, near B. Gibson's, on Fishing creek,	710'
Forks at P. McHenry's,	720'
Fishing creek there,	705'
Bridge at Benton,	760'
Fishing creek there,	745'
Road at Exchange Hotel in Benton,	755'
Cross-roads near Mrs. Roberts',	775'
" near D. Cole's,	800'
Fishing creek at Cole's mills,	785'
Forks of road north from J. Swartout's,	850'
Level of Fishing creek there,	810'

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41. Jackson township.

This township lies west from Sugar Loaf and Benton, adjoining Sullivan county.

Little Fishing creek makes its western boundary and drains southward; while *Green*, *West*, and other small creeks drain the rest of its area eastward into Big Fishing creek, the West Branch of which passes eastward across the extreme northern point of the township.

North mountain occupies the northern end and is capped with the basal members of the *Pocono beds.*

The Catskill rocks cover the surface south of it to the vicinity of Polkville, where the *transition* (*VIII–IX*) *and Chemung beds* come in and extend to the southern line of the township.

No direct evidence of *glaciation* was observed in this township, except many heaps of *Pocono sandstone and Catskill rounded bowlders* occurring on the summit of the hills west from Polkville at an elevation of 1200′ A. T. As some of them are scratched, the evidence would seem to be strong that they mark the former spread of the *Glacial Ice* over the northern portion of the township; for, these bowlders could hardly have been transported to their present position by any streams of water, because Little Fishing creek valley is just west of them and more than 200′ lower than the elevation of the bowlder beds. How far south-

ward the ice moved is uncertain, but probably not to the southern line of the township. There may have been a local glacier disconnected from the main *sheet.*

Catskill red beds occur along Little Fishing creek at Mendenhall's mill, and southward from that to where the road recrosses the creek into this township. They dip northward 10°–15°.

Southward from the latter point no more *red beds* are seen, but the rocks are mostly covered up by bowlders and gravel deposits, so that the exact junction between the *Chemung* and *Catskill-Chemung beds* could not be seen, though there is little doubt that the *Chemung rocks* cover all of Chestnut Grove and Forks school-districts.

Barometric elevations in Jackson.

Forks of road north from J. W. Kitchen's,	1050′
Level of West creek at road-crossing next south,	990′
Forks of road near J. Meaker's,	1100′
" " next north-east of York's school-house,	1190′
" " near York's school-house,	1120′
Level of stream near York's school-house,	1100′
Forks of road near F. Weil's,	1200′
" " " E. York's,	1280′
" " 205 rods south of last,	1215′
" " near S. Hartman's,	1125′
" " 149 rods west of last,	1200′
Little Fishing creek at Mendenhall's mill,	985′
" " " at road-crossing next below,	965′
Forks of road at I. Derr's,	915′
" " at N. Chamberlain's,	895′
Little Fishing creek at N. Chamberlain's,	865′

42. Pine township.

This township lies next south-west from Jackson along Lycoming county.

Little Fishing creek makes its entire eastern boundary for nearly 12 miles.

The Pocono rocks are not found in this area, but the northern portion is covered by *Catskill beds* as far south as the mouth of *Late's run,* where the *transition* (*VIII–IX*) *beds* come up which with the *Chemung* further south cover

the remaining portion of the township; except a narrow fringe of *Hamilton* along Little Fishing creek for about one mile before it leaves the township.

The valley of Little Fishing creek is quite deep and narrow, the bluffs on either side rising very steeply to a height of 200′ or more above the level of the stream, while the slopes are so deeply covered with surface débris that but few rock outcrops can be seen.

Barometric elevations in Pine.

	A. T.
Little Fishing creek at crossing north from Jacob Christian's,	845′
Forks of road at Jacob Christian's,	850′
Little Fishing creek at mouth of Late's run,	810′
" " " near S. Eckman's,	760′
" " " at J. Lawton's,	700′
" " " at Sereno P. O.,	665
" " " at southern line of township,	590′

43. *Madison township.*

This adjoins Pine township, and has Lycoming county on the north and Montour on the west.

The eastern half drains into Little Fishing creek which forms a portion of its eastern line, while the western half drains westward into Chillisquaque creek and thence into the West Susquehanna river.

The Milton axis passes east and west nearly through the center of this township, and brings up the *Hamilton rocks* in a valley two to three miles wide at the west, but which contracts toward the east until near Little Fishing creek it is not more than a mile and a half in width; *Chemung rocks* making ridges on the north and south 300′-500′ high.

The Chemung beds extend from the edge of this Hamilton valley over all the northern portion of the township and far into Lycoming county. To the south of the valley they make the surface rocks to near the southern township line where the *Chemung-Catskill* and basal members of the *Catskill* make a broad band of red.

Black shales are seen in going westward from Little Fishing past Mrs. Walliver's, opposite Ayer's Grove. They

very probably belong to the horizon of the *Genesee beds*, since just west from S. Johnson's the ashen-gray shaly *Tully limestone* layers crop out along the road.

Many rounded bowlders of *Pocono* and *Catskill sandstone* occur on the summit of the Hamilton valley in the vicinity of Mr. S. Johnson's, extending up to 700′ A. T. or 140′ above the level of Little Fishing creek.

Just west from R. Manning's these bowlder deposits are quite thick and extend up to 720′ A. T.

Hamilton beds are seen one mile north from the last locality near Ellis' tannery, dipping gently toward the south; but on going 240 rods further north to J. P. Runyan's, the rocks dip northward, thus showing that the *Milton axis* crosses between the two points.

Loxonema delphicola? was found in a nodule of ferrous carbonate imbedded in gray shales just north from P. Runyan's, a few feet under the *Tully limestone.*

The Genesee shale comes down in passing northward from the last locality, and was once drifted into for *coal* opposite the Spruce Run School-House just below L. Schuyler's, its bituminous slates having suggested the presence of that mineral to the land owner. It is, of course, needless to state that no *coal* can be found anywhere in this township.

Genesee beds also crop out at the forks of the road near I. Mordan's; and about one half mile further north the Chemung hills begin.

The black Genesee shales occur on the headwaters of Chillisquaque creek near D. W. Vandine's, where they outcrop along the road for 200 yards dipping north at the rate of 12°–15°.

The Tully limestone comes up under the *Genesee beds* and is quite well exposed at the roadside just north from C. Kramer's, where it seems to have thickness of 30′–40′, is of an ashen-gray color with a tinge of yellow on weathered surfaces and a dull grayish-blue on fresh fracture. It is quite fossiliferous, containing numerous specimens of *Ambocœlia umbonata*, *Phacops rana*, *Dalmanites calliteles*, *Spirifera Ziczac*, and *Atrypa reticularis.*

Just south from the cross-roads at M. Thomas' the brown

shales of the *Hamilton* proper are exposed at the roadside, where they are filled with *Spirifera mucronata* in great perfection.

Rounded bowlders in great heaps occur up to the *highest levels* of this Hamilton area in the vicinity of Jerseytown.

Hamilton beds nearly horizontal occur along the road near Mr. Stout's, just south from the latter village.

The Tully limestone beds come down on the south-east dip and crop out along the road a few rods south from where the Danville road turns off near G. W. Supplee's. They have the same dirty-gray weathered surface so peculiar to this stratum, and also contain the same *fossils* as those noted near Vandine's.

On going still further south the *Genesee beds* dip under and then the *Chemung* hard rocks make a high ridge trending away toward the east and west.

Chemung beds are seen near A. J. Carr's, 235 rods south from G. W. Supplee's, dipping S. 10° E. 20°, and this increases as we go further toward the south-east so that the basal members of the *Catskill-Chemung* begin to come down at the forks of the road near the Townsend Estate, one mile north from the southern line of the township. In passing still further south from Townsend's the rocks are all *red*, and several hundred feet of *Catskill* are caught in the *Lackawanna syncline*, the axis of which pases nearly parallel to the southern line of this township, and only a few rods south from it.

Barometric elevations in Madison.

	A. T.
Little Fishing creek at crossing near south line of township,	535'
L. Fishing creek at crossing south from R. Watson's, ...	545'
Forks of road near R. Watson's, ...	570'
L. Fishing creek at crossing north from R. Watson's, ...	555'
L. Fishing creek at crossing opposite Ayer's Grove, ...	560'
Forks of road near Rebecca McEwen's, ...	690'
" " " 85 rods north-west of last, ...	610'
Level of Spruce run just west, ...	585'
Forks of road at Ellis' Tannery, ...	645'
Spruce run there, ...	630'
Forks of road near J. P. Runyan's, ...	700'
Spruce run here, ...	675'

Forks of road near J. Mordan's,	780′
" " " " J. Cox's,	1315′
" " " " J. L. Moses',	1280′
Cross-roads next west near Luth. Ch.,	1180′
Chillisquaque creek at D. W. Vandine's,	800′
Forks of road near there,	810′
By-road at J. S. Stetler's,	680′
Chillisquaque creek here,	670′
Cross-roads near M. Thomas',	630′
Forks 115 rods next south-east,	650′
" near P. Richard's,	700′
By-road near Mrs. Axe's,	660′
Cross-roads near J. Allen's,	660′
" in Jerseytown,	600′
Forks of road near J. Stout's,	600′
" " " " G. W. Supplee's,	700′
" " " " J. Carr's,	900′
" " " west of A. J. Moist's,	885′
" " " near W. Mosteller's,	865′
" " " " Townsend Est.,	955′
Cross-roads near H. Christian's,	890′
Forks of road near J. Folk's,	890′

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44. Greenwood township.

This area lies next east from the northern half of Madison, being separated from it and Pine by Little Fishing creek; which meanders along its western border for more than eight miles; draining only a very narrow zone from this township; for, except within the *Hamilton area*, it is bordered by high bluffs of *Chemung* the tops of which slope away eastward and drain into Green creek, a tributary of Big Fishing.

The Milton axis brings up an area of *Hamilton rocks* about two and a half miles broad along the southern border.

The Chemung beds make a high ridge rising abruptly from the Hamilton valley, at the extreme southern line of the township, and also another one rudely parallel to the latter and about 2½ miles north from it; where the rocks dip north on the north side of the *Milton axis*. From the northern ridge the *Chemung* spreads northward and covers all the rest of the township in that direction.

The Genesee black shale is seen rising out of Little Fishing creek just below *Ayer's Grove*, at the south-western point of the township, from which locality it arches up over the broad and gentle *Milton axis*, and descending to the north-west passes under Little Fishing creek again at the road crossing near the School-House one mile above Iola P. O.

Northward from this the *Chemung beds* make cliffs very frequently along the creek road and are quite *fossiliferous* at many points; the *Stony Brook beds*, seen near the northern portion of the township, being specially rich in the organisms which characterize them. (See page 72.)

A sandstone quarry at the very base of the *Chemung* was once operated near the Mount Pleasant township line. It furnished nothing except rough stone for building walls and other purposes where cut stone was not required. In some of the layers occur many *Crinoidal fragments* and a small Brachiopod which could not be distinguished from *Ambocœlia gregaria.*

The heaps of rounded bowlders seen everywhere in the Hamilton valley to the westward in Madison, also continue eastward through this township.

Barometric elevations in Greenwood.

	A. T
Little Fishing creek at north line of the township,	810'
Forks of road just south near mill,	825'
" " 857 rods south of last,	785'
Little Fishing creek here,	765'
Forks of road near S. Greenly's,	740'
" " at School-House,	665'
Road in Iola,	605'
Little Fishing creek here,	600'
Cross-roads at Dr. Heller's,	605'
Creek there,	685'
Forks near C. Eve's,	570'
Run crossing here,	570'
Little Fishing creek at Ayer's Grove,	560'

45. *Fishing Creek township.*

This large area lies between Greenwood and Luzerne county.

Big Fishing creek flows southward through its center, and receiving Huntington creek from the east near the southern border drains all the township except the western portion which sends its rain-fall into *Green creek.*

The rocks exposed in this township extend from the *Pocono* down to the top of the *Hamilton.*

The Pocono beds make the long, high mountain (variously known by Huntington, Fishing creek, and other names) which extends in a straight line along the southern boundary, being in fact the pointed end of the Lackawanna syncline.

This mountain has been preserved from erosion by its coping of *Pocono conglomerate* with a steep south dip. The crest of the mountain runs at about 1500′ A. T.

The Catskill beds occupy the northern face of this mountain, and the slope descends almost precipitously into Huntingdon creek which flows along the northern foot of the mountain 800′–1000′ below its crest.

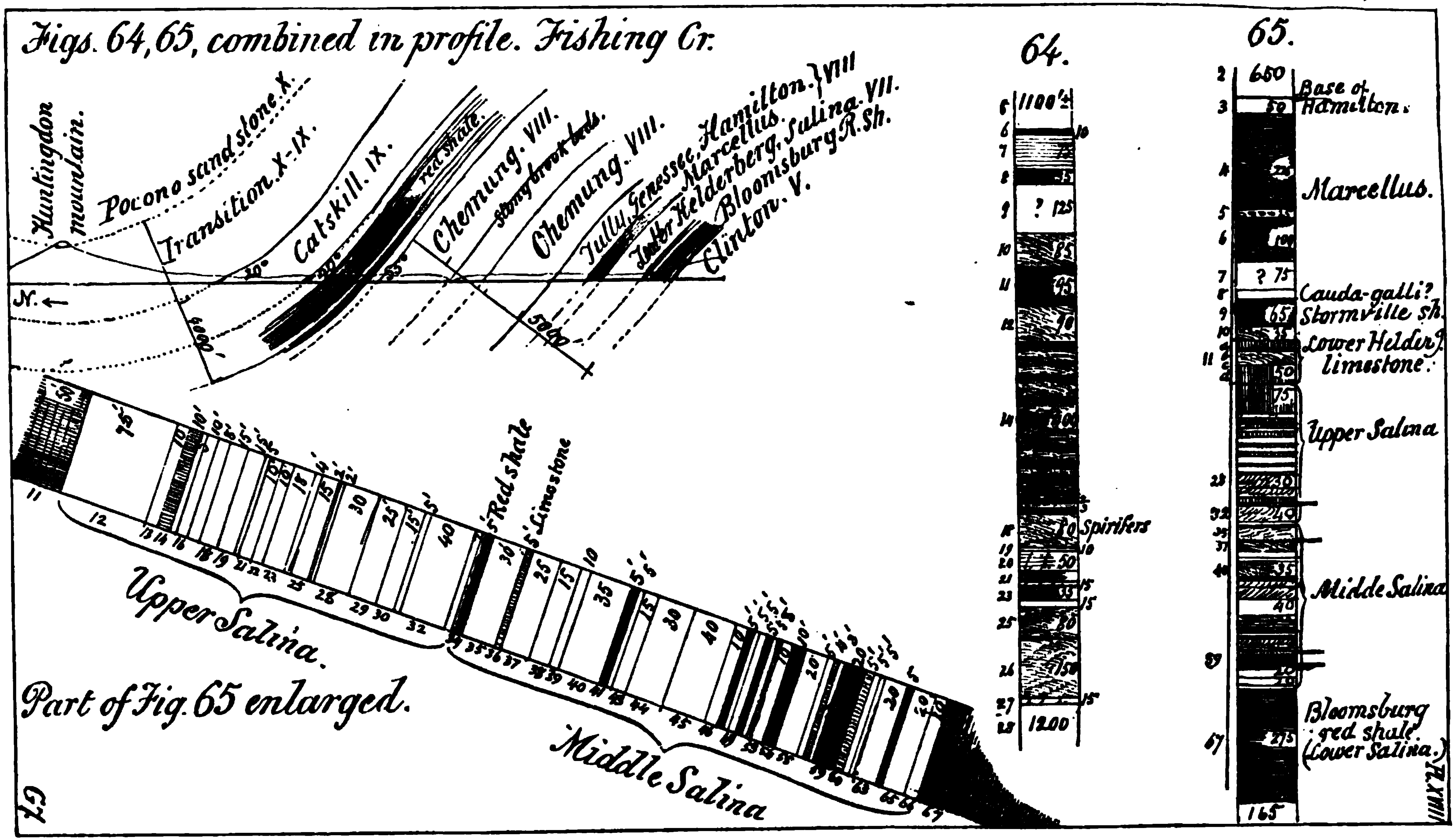
The Catskill rocks also extend north of Huntingdon creek from one half to two thirds of a mile, all the time dipping rapidly (30°–45°) southward.

Along Big Fishing creek the basal members of the *Catskill-Chemung* come up near the store-house at U. P. McHenry's, and near the eastern line of the township the base of the series is found at the cross-roads near J. Harrison's, thus making a belt of outcrop occupied by the *Catskill,* and *Chemung-Catskill* about 400 rods broad along the southern border.

The Chemung beds come up just north of the *Chemung-Catskill* outcrop and cover all the rest of the township except where erosion has removed them from the crest of the *Milton axis* on Big Fishing creek and westward from it.

This axis crosses Big Fishing creek, just south from the village of Still Water, and elevates the *Genesee beds* above water level, and possibly a small portion of the *Hamilton proper* at the very crest of the arch.

A cliff of Genesee shales 150′ high is seen on the east bluff of Fishing creek, directly opposite the forks of the



Figs. 64, 65, combined in profile. Fishing Cr.
Huntingdon mountain.
Pocono sandstone X.
Transition X-IX.
Catskill. IX.
red shale.
Chemung. VIII.
Stony brook beds.
Chemung. VIII.
Tully, Genessee, Hamilton. } VIII
Marcellus.
Lower Helderberg, Salina. VII.
Bloomsburg R. Sh.
Clinton. V.
N. ←
5000'
6000'
64.
Spirifers
65.
Base of Hamilton.
Marcellus.
Cauda-galli?
Stormville sh.
Lower Helder. limestone.
Upper Salina
Middle Salina
Bloomsburg red shale. (Lower Salina.)
5' Red shale
5' Limestone
Upper Salina.
Middle Salina
Part of Fig. 65 enlarged.
G 7.
PL. XVIII

road near D. McHenry's. The beds still dip gently (5°–6°) southward at this point.

The Chemung beds are well exposed on Big Fishing creek from where the road crosses the little stream at J. Dewitt's on southward for nearly half a mile, the layers dipping S. 10° E. 35°.

The Stony Brook beds come down just north from Mr. W. Stecker's where they are very *fossiliferous* and of an olive-green color.

Chemung rocks are also seen at the roadside where the bridge crosses Big Fishing creek in the village of Still Water, and as they dip quite gently northward, the *Milton axis* must pass southward of this point.

The Glacial ice seems not to have covered the crest of Huntington mountains in this township, since, along the road which crosses it from Jonestown no *Drift bowlders* could be found at an elevation higher than 400′ below the summit. The Ice, however, filled the Huntington creek valley to 400′–500′ above the bed of the stream, and heaped up a great *Terminal Moraine* which runs from about one mile east of the junction of Huntington and Big Fishing creeks, north, to the northern line of the township.

These deposits make a wide plain along Huntington creek, rising suddenly to 60′–75′ above the water level, com posed principally of *Pocono* and *Catskill* bowlders ½′–3′ in diameter, some rounded and others angular, and also some of them exhibiting the characteristic striations of Glacial action.

This western limit of the Ice passes near the villages of Asbury and Van Camp.

Barometric elevations in Fishing Creek.

	A. T.
Junction of Huntington and Big Fishing creeks,	**600′**
Forks of road at E. Robbin's,	**670′**
Huntington creek here,	**625′**
By-road to H. Cline's,	**725′**
Forks of road at A. Park's,	**740′**
Summit of Huntington Mt. on road leading south from Jonestown,	**1500′**
Huntington creek at Jonestown,	**680′**

Cross-roads in Jonestown,	695′
Forks of road at M. Hoyt's,	740′
Cross-roads near J. Harrison's,	725′
Crossing of Pine creek near J. M. Buckalew's,	715′
Cross-roads at H. C. Cline's,	755′
Forks of road west from N. Miller's,	740′
Level of run crossing here,	720′
Forks of road north from J. Allegar's,	775′
By-road to P. Weaver's,	960′
Cross-roads next north,	925′
" " at S. Yost's,	985′
Forks at Van Camp P. O.,	1175′
Summit near P. Creveling's,	1250′
Raven's creek at J. Sutton's,	780′
" " at crossing above Stillwater P. O.,	685′
Big Fishing creek at Stillwater P. O.,	685′
Forks of road at M. McHenry's,	710′
Big Fishing creek at J. Coleman's Saw Mill above the dam,	710′
Forks of road north from H. McHenry's,	700′
Big Fishing creek opposite L. Stoker's,	645′
Cross-roads here,	660′
Ger. Reformed Church forks,	675′
Forks near H. Pealer's,	635′
Store next below,	640′
Forks next west from P. Bogart's,	985′
" " north of last,	980′
" " west " "	900′
Run at road crossing near J. F. Shoemaker's,	750′

46. Orange township.

This borders Fishing creek township on the south-west, and has Greenwood on the north. It is drained entirely by Big Fishing creek, which flows westward through it, and then along its western border, receiving Green creek as a tributary from the north near the center of the township.

The rocks which cover its surface belong in the series from the *Pocono* to near the base of the *Chemung*.

The Lackawanna syncline passes from east to west nearly through the center of the township. The *Pocono* mountain ends in a bold point just east from Orangeville called *Knob mountain*.

From the summit of this mountain, near Orangeville, a very wide view can be obtained, and it is especially fine after the leaves have fallen, when the eye has an unbroken

sweep from the North mountain crest at the Lycoming line around to the west over nearly all of Columbia and Montour counties, and eastward over much of Luzerne.

A broad belt of *Catskill* crosses the township, dipping steeply both ways inward towards the *synclinal axis* which passes under Orangeville, and crosses Big Fishing creek at the road-crossing near M. C. Vance's.

The Chemung rocks cover the rest of the township north and south from the *Catskill belt*, and in both directions the rapid dip almost brings up the top of the *Hamilton* at the north and south lines of the township.

Big Fishing creek, after flowing westward through this area along the *strike* of the *Catskill beds*, veers southward at Bowman's mill and cutting across the *synclinal axis* passes squarely through the lower half of the *Catskill*, the *transition beds*, and nearly all of the *Chemung*.

In passing along the road which descends Fishing creek at the western line of the township the following section was constructed by pacing the intervals and observing the dip:

Section along Fishing creek, (*Fig. 64, page 212.*)

1. ***Red sandstone and shales***,	20′
2. Sandstone, greenish, micaceous,	10′
3. ***Red shale***, sandy,	25′
4. Sandstone, greenish-gray,	10′
5. Concealed; (this interval begins where the road turns south 250 yards north from S. Seybert's upper house where the dip is N. 15° W. 20°, and at the base of the interval, 115 yards south from the lower house, the dip is N. 15° W. 40°,) thickness of intervening rocks about	1100′
6. ***Red shales***, sandy,	10′
7. Mostly grayish-green sandstone with little red material,	75′
8. ***Red shale***,	35′
9. Concealed,	125′
10. Shales, greenish, sandy,	85′
11. ***Red shales***,	95′
12. Shales, green and red,	90′
14. Alternate green and red sandy beds, ***more red*** than green,	400′
15. Sandstone, grayish-green,	2′
16. ***Brecciated limestone***,	3′
17. ***Red shale***,	20′
18. Olive shales with ***Spirifera disjuncta***, (or a large coarse one very much like it,) dip 55° N. 15° W.,	80′
19. Sandstone, flaggy, dip 55°,	10′

20.	Sandstone, greenish-gray,	50′
21.	*Purple sandy shales,*	25′
22.	Sandstone, greenish-gray, flaggy,	15′
23.	*Purplish-red beds,*	35′
24.	Concealed,	15′
25.	Olive shaly beds with some *purple,*	80′
26.	Olive and yellowish shales,	150′
27.	Sandstone, greenish, flaggy, once quarried here,	15′
28.	Concealed to crossing of Stony Brook,	1200′
29.	Concealed,	75′
30.	*Stony Brook beds,* a series of olive-green, sandy shales very fossiliferous, and especially rich in *Leiorhynchus mesocostale, Spirifera mesocostalis, S. disjuncta, Productus hirsuta,* and many others, very finely exposed at a cutting along the road where the latter crosses Stony Brook, . . . visible	50′
31.	Concealed,	650′
32.	Shale, yellowish-green, containing *Spirifera disjuncta,*	5′
33.	Concealed to base of *Chemung* at south line of the township,	1300′
		5860′

Summary.

Catskill beds, Nos. 1-17 inclusive,	2105′
Transition beds, (*Catskill-Chemung,*) Nos. 18–800′ down in No. 28,	1275′
Chemung beds, from 400′ above base of No. 28–33 inclusive,	2480′
Total thickness of beds,	5860′

No. 1. The rock interval from the base of the *Pocono* in the top of *Huntington mountain* (one mile east from where the section begins) down to the top of No. 1 is not far from 2000′; which, added to the *Catskill* in the above section, would make that entire series about 4100′ thick in the vicinity of Orangeville. Should we include the *Chemung-Catskill* (Transition) down to the *lowest red bed,* we would have a thickness of nearly 5400′ This is very close to the thickness obtained for the *Catskill* and *Transition* on the south side of the Lackawanna syncline, where the North Branch of the Susquehanna cuts through it south from Shickshinny.

No. 18. The base of the *Catskill proper* is taken at the top of No. 18 because at that horizon we find the first rocks with any resemblance to the lithological aspect of the *Chemung beds,* and also find in them a *fossil shell, Spirifera disjuncta?* that is common in the *Chemung.* I have given

reasons elsewhere (see page 63) for the propriety of establishing these *beds of passage*, a series intermediate between the *Chemung* and *Catskill* but allied to both by several bonds. I have placed the base of the *transition beds* here at 475' above the *Stony Brook beds*, since that is about the average interval found elsewhere in this county between these beds and the *lowest red bed*, the base of the *series*.

No. 30. The Stony Brook beds were named from this locality, the mouth of the little stream one half mile north from the south line of the township where this remarkably fossiliferous horizon is so well exposed. From this locality Prof. Claypole identified the species given on page 72, Chapter IV.

The lithological character of the beds taken in connection with the association of fossils found in them renders this horizon very readily recognizable anywhere that it is exposed within the limits of the district, the same beds having been distinctly identified near the southern point of Northumberland county.

No. 33. The beds in No. 33 are all covered up by *terrace deposits* on the east bank of Big Fishing creek along which the section was made; but on the opposite side, in Mt. Pleasant township, they are almost perfectly exposed; very hard, greenish-gray and bluish-green sandy beds containing but few fossils.

Holoptychius Americanus represented by some scales was found by Prof. Claypole in some red, sandy shale near the western line of the township on the road that leads westward from Orangeville to Canby in Mt. Pleasant. It comes at the same horizon as the *Fish-bed* in the section below Rupert, viz: 1000' above the top of the *Chemung.*

Great heaps of *rounded bowlders* are scattered over the highest hills in the portion of this township east and south from Big Fishing creek, up to 950' A. T.

They look like genuine Drift heaps; but Prof. Lewis is confident the *ice* did not come this far west, and I could not find any evidence of glaciation in the rocks themselves or the underlying beds. Some of the bowlders are angular and 2'-3' in diameter. They belong mostly to the *Pocono* and *Catskill series.*

If not transported to their present positions by the *Ice sheet* they form an important link in the chain of evidence that the sea-level once stood at least 1,000 above its present datum.

A broad terrace of small rounded bowlders 8′–10′ above the water spreads from Big Fishing across to Green creek, one mile above their junction. A very thick deposit of bowlder trash is also seen along the east bank of Big Fishing creek for one mile north from the southern line of the township, it rises 60′–75′ above the stream and makes a steep bluff.

Barometric elevations in Orange.

	A. T.
Forks of road at P. Ent's mill,	520′
" " near mouth of Stony Brook,	515′
" " near Mrs. Adams',	530′
Cross-roads near W. De Long's,	580′
" in Orangeville,	575′
Watering-trough in Orangeville,	575′
Big Fishing creek at J. M. Parker's,	555′
Forks of road near A. H. Kitchen's,	600′
" " near H. R. Cline's,	585′
Cross-roads near M. B. Patterson's,	600′
Green creek here,	585′
Forks of road near J. B. Harman's,	700′
" " 14 rods next west,	690′
Summit of Huntington Mt east from Orangeville,	1480′
Forks of road near R. Sitler's,	880′
" " 217 rods south of last,	970′
" " near S. Shuman's,	950′

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47. *Mount Pleasant township.*

This area lies immediately west from Orange, having Little Fishing creek for its western boundary and Big Fishing for its southern. The two streams unite at the southwestern corner of the township and thus partly enclose it.

The Lackawanna syncline continues, westward from Orangeville, as a zone of *Catskill* more than a mile wide directly through the center of the township.

The axis of this syncline passes just north of the village of Canby and reaches Little Fishing creek at the mouth of

Harris' run, which flows south-westward to the center of the basin.

The Chemung rocks, with a steep south dip extend to the northern line of the township, where the basal beds crop out.

The Chemung comes up south also from this syncline and covers an area nearly three fourth mile wide along the southern border of the township. Then further south the *Hamilton beds* appear, and they are succeeded by the *Lower Helderberg* and the *Salina* along the south-western portion of the township.

The section of the rocks in Orange given on the preceding pages ends at the base of the *Chemung*, because that township extends only to the beginning of the *Hamilton area.* But when one crosses to the west bank of Big Fishing, in Mount Pleasant township, the section is continued from J. Grimes' to M. Shaffer's, along that stream down nearly to the top of the *Clinton beds.*

Section along Big Fishing creek, (Fig. 65, page 212.)

1.	***Chemung***,		—	
2.	***Genesee slate*** and ***Tully limestone***, concealed under débris, thickness about,		650′	
3.	Shales, dark, olive sandy *fossiliferous* containing ***Spirifera mucronata***, ***Ambocœlia umbonata***, ***Tropidoleptus carinatus***, ***Orthonota undulata***, and fragments of ***Trilobites***, and ***Crinoidal stems***, base of ***Hamilton*** proper,		50′	
4.	***Marcellus***, black, fissile slates, no fossil seen,		225′	
5.	Dark gray, very hard rock, containing some lime and many *iron nodules*,		25′	
6.	Dark fissile slates, some gray,		100′	
7.	Concealed,		75′	
8.	Dark gray, hard, sandy slate, exactly like the *Cauda galli* of Pike and Monroe counties,		25′	
9.	Black slates and dark colored shales, no fossils seen,	Stormville shale.	65′	100′
10.	Ash-colored shales with limy beds at top,		35′	
11.	***Lower Helderberg limestone***:			
	(a.) Shaly limestone, gray,		20′	110′
	(b.) Shaly, sandy limestone,		10′	
	(c.) Shales, drab, limy,		30′	
	(d.) Bluish-black limestone, somewhat shaly and flaggy,		50′	

12.	Pale buff and greenish magnesian limestones, and concealed, the lower most greenish,	75′
13.	Shales, limy, greenish-gray,	10′
14.	Massive limestone, pale green, impure,	10′
15.	Concealed,	5′
16.	Impure limestone and shales,	10′
17.	Concealed,	8′
18.	Buffish, shaly limestone,	15′
19.	Pale green magnesian limestone,	15′
20.	Bluish-gray limestone, impure,	5′
21.	Buff, limy shales,	10′
22.	Shaly, blue limestone,	10′
23.	Buffish and green shales,	18′
24.	Bluish-gray, impure limestone,	4′
25.	Pale green shales, limy,	15′
26.	Bluish-gray limestone, rather pure,	2′
27.	Buff shales,	2′
28.	Pale green shaly limestone and limy shales,	30′
29.	Pale green, limy shales,	25′
30.	Buffish, magnesian limestone,	15′
31.	Blue, shaly limestone,	5′
32.	Greenish, limy shales,	40′
33.	Pale green shale with purplish cast,	7′
34.	*Red shale*, contains 10–12 per ct. of iron,	5′
35.	Shales, pale green,	30′
36.	Buff and bluish magnesian limestone,	5′
37.	Pale green, limy shales,	25′
38.	Concealed,	15′
39.	Bluish, limy shales,	10′
40.	Greenish shales,	35′
41.	*Red shales*,	5′
42.	Concealed,	5′
43.	Greenish-gray sandy shales,	15′
44.	Pale green shales,	30′
45.	Concealed,	40′
46.	Green shales,	10′
47.	*Red shale*,	5′
48.	Concealed,	5′
49.	Green shale,	5′
50.	*Red shale*,	5′
51.	Red and green shale,	5′
52.	*Limestone*, bluish-gray, good,	3′
53.	Green shale,	10′
54.	*Red shale*,	10′
55.	Green shale,	20′
56.	Limy shales,	5′
57.	*Limestone*, fair, gray,	4′
58.	Green shale,	3′
59.	*Red shale*,	20′
60.	Limestone, gray, impure,	5′
61.	Concealed,	5′
62.	Green shale,	5′

63. Concealed, ... 20′
64. *Red shale*, ... 5′
65. Greenish shales and thin bluish-gray, impure limestones, ... 20′
66. Green shale, ... 10′
67. Deep red shale, *Bloomsburg*, sandy in some portions, makes cliffs to near M. Shaffer's where it passes under; thickness, ... visible, 275′

Summary.

Hamilton, including *Genesee*, *Tully* limestone and *Hamilton proper*, (Nos. 2–3,)	VIII,		700′
Marcellus beds, (Nos 4–7,)	VIII,		425′
Cauda Galli Grit? (No. 8,)	VIII,		25′
Oriskany Sandstone, (VII,)			absent
Stormville shales, (Transition VII–VI,)			100′
Lower Helderberg Limestone, (VI,)			110′
Salina,	Upper Nos. 12–33 inclusive,	329′	1011′
	Middle Nos. 34–66 "	407′	
	Lower (*Bloomsburg red shale*,)	275′	
From base of Chemung down,			2,371′
From base of Pocono to Hamilton,			7,860′
From base of *Pocono* to top of *Clinton*, about			10,300′

Say 10,000′, since the top of the Clinton beds comes only 165′ under the base of the 275′ red shale seen in the section given above.

No. 2. The thicknesses given in this section may be regarded as practically exact except in No. 2, which being covered was calculated on a dip of 40° ; possible error 50′.

Hamilton. It will be seen that this gives the entire *Hamilton formation* a thickness of 1150′, which is only about half of that found on the south side of the *Montour axis*, three miles south from this locality.

No. 8 is doubtfully referred to the *Cauda galli grit* simply on its stratigraphical position and its lithological characters, in the latter of which it perfectly agrees with the *Cauda galli* of Pike and Monroe, even to the rough *cleavage structure* so common to these beds in the counties named. If it does not truly belong to that geological horizon it is certainly a very remarkable simulation of the *Cauda galli character* by the basal member of the *Marcellus beds*.

Nos. 9, 10: *The Stormville shales* seem to be represented

Plate. XIX.

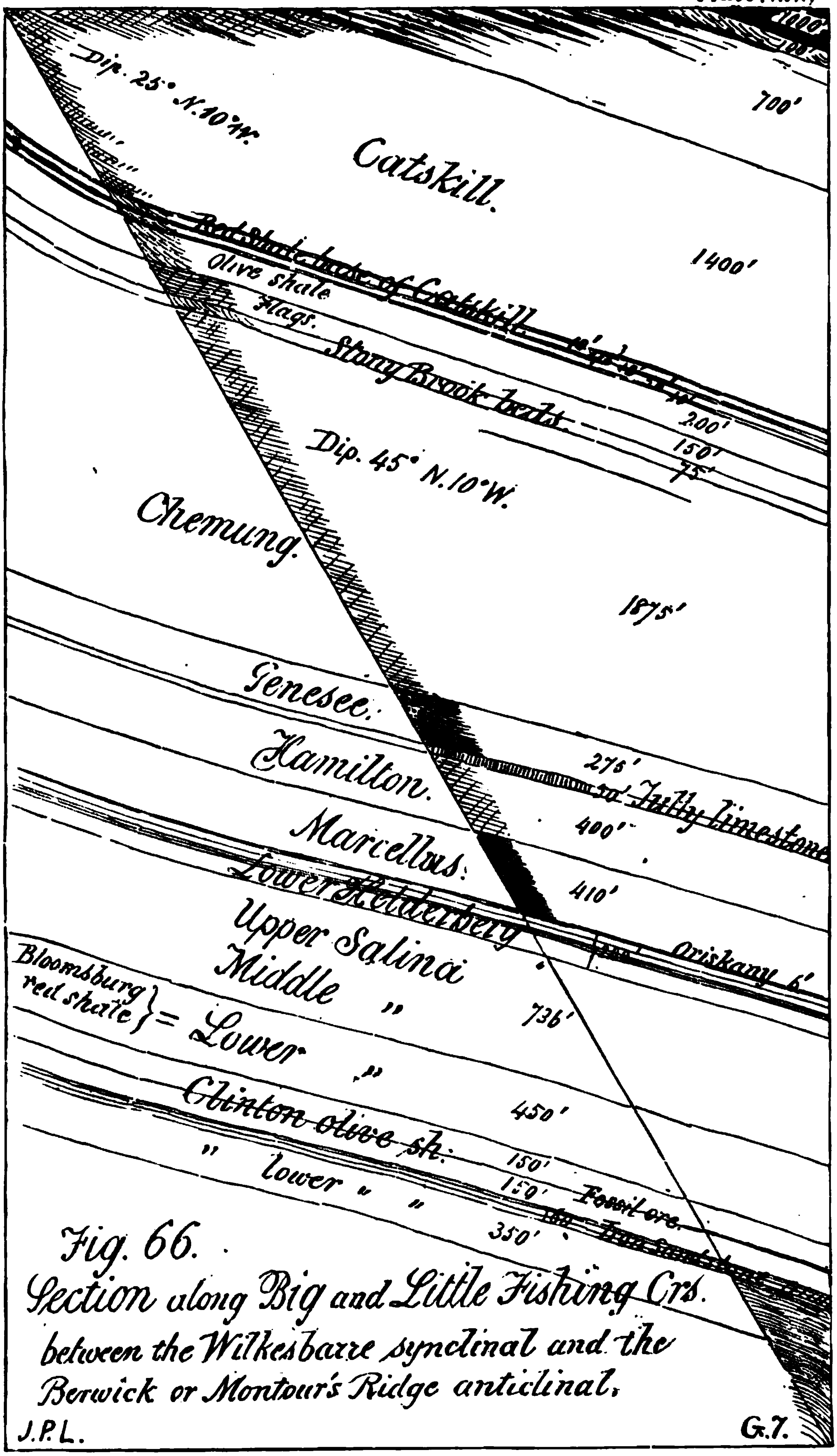


Fig. 66.
Section along Big and Little Fishing Crs.
between the Wilkesbarre synclinal and the Berwick or Montour's Ridge anticlinal.

by Nos. 9 and 10, but if No. 8 be *Marcellus* then No. 9 is probably also *Marcellus;* leaving No. 10 *Stormville shales* with a thickness of 35′ instead of 100′. If No. 8 be *Cauda galli* possibly a portion of No. 9 may also be so.

The Oriskany sandstone is completely absent at this locality though it comes in two or three miles west from this, but only 5′–6′ thick.

No. 11. The Lower Helderberg limestone is here much thinner than usual and quite impure, the only portion fit for burning into lime being some parts of (*d*) which seems to represent the *Bossardville beds* of Pike and Monroe, but even this is impure, so that an attempt to burn it for the market has not been entirely successful.

Nos. 12 to 67. For the splendid exposure of the *Salina rocks* (Nos. 12–67) I am indebted to the recent construction of a road along the west bank of Fishing creek where the rocks rise abruptly from its bed, thus requiring almost a solid rock cut for the road bed, from the base of the *Hamilton* proper down nearly to the *Clinton;* thereby completely exposing for measurement and study a portion of the series (*Salina*) which could not otherwise have been seen in detail anywhere within the district.

My reasons for regarding these beds as identical with the *Salina series* of New York have been already given in a previous part of this report (see Chapter V, page 101,) and need not be repeated here.

The limestones are slightly *magnesian*, and some of them would possibly make *hydraulic cement.*

They are locally known as "Sulphur stone" because when heated they exhale fumes of sulphur, as if containing *gypsum*, though I saw none in the rock.

Nos. 51, 57. Some of the limestones down near the base of the series (as Nos. 51 and 57) are not magnesian, and would burn into a fair quality of lime. They are possibly identical with the *Poxono limestone* of Monroe county. The *Poxono shales* of Report G⁶ are undoubtedly identical with the *Upper* and *Middle beds* of this section.

No. 67. The Bloomsburg red shale, No. 67, at the base of the *Salina*, is exactly such a stratum as occurs at the

same horizon in New York. It also has occasional thin patches of *light green* interlaminated with the *red.*

No fossils were observed in them at this locality.

The entire thickness of this *red shale* member of the *Salina* down to the *Clinton* is not far from 450′.

The top of the *Chemung* dips under to the north on Little Fishing creek, about one half mile below Beagle's mill; and rises above the same on a south dip about two miles above, or near the crossing of the creek above Mordansville.

Just above this latter village much *red rock* occurs along the road dipping S. 10° E. 30°; further north 200′–250′ of greenish shales; below which green sandstones occur. These are all in the *Catskill-Chemung series.*

Barometric elevations in Mt. Pleasant.

Big Fishing creek at crossing east from J. White's, ...	510′
Forks of road near J. Grime's, ...	520′
Junction of Big and Little Fishing creeks, ...	475′
Cross-roads in Mordansville, ...	545′
Little Fishing creek here, ...	530′
" " " at crossing next above Mordansville, . .	535′

48. *Hemlock township.*

This township extends west from Mount Pleasant to the Montour county line.

Big and Little Fishing creeks form its eastern boundary and separate it from Mount Pleasant and Bloomsburg. They also receive its entire drainage, except from a small region at the extreme western portion which goes westward down the old Hamilton-Salina valley to the Susquehanna at Danville.

The Clinton beds with the included *fossil iron ores* cover a belt about one mile wide along the southern border of the township, the central line of the *Berwick axis* making a prominent elevation which westward from Fishing creek has long been known as *Montour ridge.*

Next north from the *Clinton* ridge the *Salina, Lower Helderberg*, and *Hamilton* dipping rapidly northward make

a wide valley covered with rounded bowlders and trash to a considerable depth.

A branch of Hemlock creek flows eastward in this old valley; while another stream heading up against it on a low divide goes westward down the same valley to Mahoning creek in Montour county.

The Chemung beds make a belt of north dipping rocks nearly a mile wide, rising into abrupt hills overlooking the valley just mentioned.

The Lackawanna synclinal enters the north-eastern corner of this township, and makes a narrow belt of *Catskill rocks* across it.

Little Fishing creek trenches southward squarely across the *Lackawanna syncline* and the rapidly north dipping beds to the south of it; while Big Fishing creek, after receiving the latter, continues its course S. 10° E. at right angles to the strike of the rocks until after it cuts through the *Berwick axis* and passes south from Montour Ridge; then it veers off to the south-west diagonally across the *Salina valley.*

The exposures along this line are unusually fine, owing to recent rock cuttings in grading a new road down the western banks of Little and Big Fishing creeks, so that the two streams give an almost complete section from the *Catskill* down to the basal beds of the *Clinton*, as exhibited in the following:

Section along Little and Big Fishing creeks between the Lackawanna synclinal and the Montour anticlinal (*Fig. 66, page 222.*)

1.	***Red shales***, green sandstones and concealed from center of ***Lackawanna syncline*** (dip 20°–30° N. 10° W.) about	1000′
2.	Shales, olive and green, ...	100′
3.	Concealed with frequent appearance of ***red beds***, (dip about 25° N. 10° W.,)	700′
4.	Green sandstones, concealed, and olive-green shales, . .	1400′
5.	Sandstone, rather massive, yellowish-green, ...	10′
6.	Olive-brown shales, ...	40′
7.	***Red shale*** base of Chemung-Catskill, ...	10′
8.	Olive shales, soft, ...	50′
9.	***Sandstone***, grayish, some ***flat quartz pebbles***, ...	10′
10.	Soft olive shales, ...	200′

11. Hard, sandy, flaggy beds, greenish, ... 150
12. Olive-green, sandy *fossiliferous* shales and shaly sandstones, *Stony Brook beds*, ... 75'
13. Hard, grayish-blue and dark-olive sandy beds, (dip 45°–50° N. 10° W.,) . . . . 1875'
14. *Genesee shale*, dark-blue and blackish sandy shales and slates, ... 275'
15. *Tully limestone*, bluish-gray, impure, fossiliferous beds weathering dull gray, ... 50'
16. *Hamilton beds*, brown, gray and bluish, sandy shales, and slates quite *fossiliferous*, being filled at several horizons with the common Hamilton species, . 400'
17. *Marcellus slates*, a series of black and dark-blue slates and shales quite fossiliferous near the top, and dipping N. 10° W. 30°, ... 410'
18. *Oriskany sandstone*, a bed of sandy chert containing *Spirifera arenosa*, ... 6'
19. *Stormville shale*, dark bluish and blackish shales, . . 2'–15'
20. Limestone, top of *Lower Helderberg*, bluish-gray, quite good, ... 25'
21. Bluish-black limestone, filled with calcite, ... 40'
22. Impure limestone, filled with *Beyrichias*, ... 12'
23. Blue limestone, good, ... 10'
24. Concealed to base of *Lower Helderberg* beds about . . . 100'
25. *Upper and Middle Salina beds*, a series of alternating impure magnesian limestones, pale green shales, and red shales, measured in detail about two miles east from this in Orange township where they have an aggregate thickness of . . . . 736'
26. *Bloomsburg red shale* the lowest member of the *Salina series*, consisting of deep red shales, much of it rather sandy and occasionally showing thin streaks of pale green, no fossils seen, estimated at . . . . 450'
27. *Clinton* olive shales and flaggy sandstone, *fossiliferous*, 150'
28. *Fossil ore*, a calcareous bed of *red hematite*, very hard when well under cover, but soft and disintegrated when exposed to surface water, quite *fossiliferous* varying in thickness from ten inches to one foot and a half, and usually in two layers, the *Big bed* at top 10″–12″ thick, separated from the *Little bed* below by 2′–3′ of hard calcareous rock, total, ... 3'
29. Concealed, and olive sandy beds, together with some calcareous bands, ... 150'
30. *Iron sandstone*, (a,) very hard dark red sandstone containing 10°–15° per cent. of iron, . . . 10'
(b) Shales, yellowish green with streaks of red, . . . 25'
(c) Dark brown sandstone containing thin streaks of lean iron-ore and some shales, ... 25' } 60'
31. Pale yellowish-green, and olive (Lower Olive) slates to crest of *Berwick axis*, ... 350'

Summary.

Catskill (*IX*,) Nos. 1-3 inclusive,			1800′
Transition (*IX-VIII*,) Nos. 4-7 inclusive,			1450′
Chemung beds (*VIII*,) Nos. 8-13 "			2360′
Genesee, "		275′	*Hamilton*, 1135′
Tully limestone, "		50′	
Hamilton, proper, "		400′	
Marcellus, "		410′	
Oriskany (VII,)			6′
Stormville shales (VII-VI,)			10′
Lower Helderberg (VI,) Nos. 20-24 inclusive,			187′
Salina, Nos. 25 and 26 inclusive,			1186′
Clinton. (V.)	Olive, brown, sandy beds,	150′	713′
	Fossil ore,	8′	
	Olive sandy beds,	150′	
	Iron sandstones and shales,	60′	
	Lower Olive shales,	350′	
Total thickness,			8747′

If we add to this 2200′ for the rest of the Catskill up to the *Pocono beds*, and 150′ for the remaining portion of the *Lower Olive shale* down to the *Medina* we have as the interval from the *Pocono sandstone* (*X*) to the *Medina sandstone* (*IV*), 11,097′.

The Catskill beds are seen along Little Fishing creek from the vicinity of Beagle's mill northward to the northern line of the township.

The axis of the *Lackawanna basin* in which the Catskill beds are found, crosses Little Fishing creek a few rods south from the bridge across that stream, nearly one mile north from Beagle's mill. Much red rock occurs all over the surface here when the outcrop is covered up by débris.

A considerable portion of the *Transition series* (*IX- VIII*) is concealed in the upper part; but from what I could judge by the surface débris, very little red shale occurs in this interval, though the uppermost 300,-400′ should doubtless be included in the *Catskill* series.

No. 12. *The Stony Brook beds* are here as everywhere else in the district filled with *Leiorhynchus mesocostale*, *Productus hirsuta*, *Spirifera disjuncta*, and many other forms. The top of this richly fossiliferous horizon comes 400′ below the *10′ red bed*, No. 7, the basal member of the *Catskill-Chemung* (*IX- VIII*) *beds*.

No. 9. *The Chemung conglomerate* is a very interesting stratum from the fact that it is quite widely distributed in the district at this horizon, and is very possibly identical with the *Falls-Creek-Cascade conglomerate* of Bradford, Susquehanna, and Wayne counties along the northern line of the State, and hence with the *3rd Venango oil sand* of the western counties, but whether exactly identical with this bed or otherwise, it certainly comes at the same general horizon, viz: *below all the red beds* and near the top of the genuine *Chemung.*

The 1875′ of Chemung below the *Stony Brook beds* are completely exposed in the continuous cutting for the road bed which descends Little Fishing creek. The rocks are for the most part very hard, bluish-gray or dark olive green, sandy beds which contain fossils quite sparingly, and in weathering break up into irregular, splinter-like pieces 3″–6″ long. They come in layers ½′–3′ thick and frequently rise in bold, ragged cliffs with jutting crags along the banks of the streams.

A part of this interval is possibly the equivalent of the *Portage series* of Western New York.

The Genesee shale is also finely exposed, and its thickness was very carefully determined. It consists largely of bluish-black shales and slates which weather gray or light gray on exposed surfaces, and are entirely destitute of *fossil remains* so far as I could determine. The thickness given, 275′, is that of the beds certainly *Genesee;* but immediately above them there come 45′ of gray, shaly beds that are much less sandy than the hard *Chemung rocks* which begin at their top. In the section I have included the 45′ with the *Chemung*, since, on the whole, they seem more closely related to the latter than to the *Genesee;* but if they really belong to the *Genesee* the thickness of this group would be increased 45′, or to 320′ instead of 275′ as given above.

The Tully limestone, No. 15, has the same ashen-gray cast with a tinge of buff on its weathered surface, and dark-blue color within, as everywhere else in the district. It is also fossiliferous here, and in it were seen *Phacops*

rana, *Dalmanites calliteles*, *Ambocœlia umbonata*, and others not determined.

The greatest surprise in this section was the small thickness (400′) of the *Hamilton proper*. The 400′ given as the thickness here is *above* rather than *below* the real thicknesses, too. For the beds are well exposed throughout, and the dip is nowhere greater than 40°, while at several places it is 4°–5° less. But in constructing the section through the *Hamilton* I have used the maximum dip.

A large *quarry* was once opened in the Hamilton here near the land of Mr. Vanderslice, and the bluish-gray slates sawed and turned into various kinds of ornamental work, such as mantels, tables, &c. The finished stone work was covered with a coat of paint, and this being burned gave the articles the appearance of dark marbles with yellowish veins and spots. The articles manufactured met with a ready sale, but financial embarrassment of the operators closed the works before the business was fairly established. The large excavations made in opening up these quarries enabled me to get the complete section of the Hamilton given above.

A richly fossiliferous layer occurs about 100′ below the top of the *Hamilton*, and from it I collected the following species which were kindly identified by Prof. Claypole:

Eoden bellistriatus, *Nucula bellistriata*, *Aviculopecten æquilaterus*, *Strophodonta perplana*, *S. demissa S. inaequistriata*, *Spirifera granulifera S. mucronata*, *S. fimbriata S. medialis*, *Tropidoleptus carinatus*, *Lingula densa*, *Orthis penelope*, *O. vanuxemi*, *Atrypa recticularis*, *Chonetes logani*, *Streptorhynchus chemungensis*, *Phacops rana*, *Beyrichia punctulifera*, *Dalmanites calliteles*, *Coleolus tenuicinctus*, *Taeniopora exigua*, and others undetermined.

At 250′ below the top the following were obtained:

Pteronites decussatus, *Eodon bellistriatus*, *Spirifera mucronata*, *Athyris spiriferoides*, *Rhynchonella sappho*, *Orthis vanuxemi*.

The following were picked from loose chips at the quarry,

so that their exact horizon is not known, though it probably comes 50′–75′ below the top of the Hamilton:

Discina media, *Ambocœlia umbonata*, *Athyris spiriferoides*, *Lingula densa.*

All of these were obtained in about four hours' work and hence it is quite probable that a thorough search would largely increase the foregoing lists.

The Marcellus beds are also very finely exposed at the quarry, for these black slates were once mined quite extensively for roofing and school slates, though they do not exhibit cleavage at this locality but are finely laminated.

The Marcellus consists largely of black slates in the upper half, and dark bluish shales and slates in the lower.

No fossils were seen in the Marcellus except near the top (10′–20′ below) where a single layer of black slate only 2″–3″ thick yielded me the following species as identified by Prof. Claypole:

Pteronites laevis, *Aviculopecten aequilaterus*, *Leiorhynchus limitare*, *Ambocoelia umbonata*, *Chonetes mucronatus*, *Discina* sp? *Spirifera* sp? *Orthoceras subulatum*, *Nautilus marcellensis.*

A further search here would doubtless reveal nearly everything described by Prof. Hall from the Marcellus beds in New York.

The Oriskany sandstone, though completely absent from the section in Mt. Pleasant township, 2 miles east from this, makes its appearance here as a bed of sandy chert only 6′ thick, in which a coarse *Spirifer* occurs evidently identical with *S. arenosa.*

The Stormville shales, No. 20, exhibit an interesting variation here where they are exposed at Vanderslice's limestone quarry. At one locality their thickness is only 2′; but toward the east they increase rapidly; and where they pass into a concealed interval have become 15′ thick in a distance of only 40′. They are quite dark and rather fissile.

The Lower Helderberg limestone has been quarried extensively on the land of Mr. T. J. Vanderslice, near where the Bloomsburg road crosses Little Fishing creek. The top

portion is quite good at this locality, and the quarrying after it caused the exposure of the *Oriskany* and underlying shale. The limestone dips northward about 45°: the *Marcellus beds* above only 30°.

The Salina beds are frequently seen, but not in so much detail as in the Mount Pleasant section already referred to; and as their thickness was there very carefully measured, I have assigned to the *Upper* and *Middle* portions the same thickness as found there.

The Bloomsburg red shale, or basal member of the *Salina*, was found to be about 750′ thick down to the upper olive beds of the *Clinton*. It is all *red* except a few thin streaks of pale green. Some of the beds are quite sandy.

The Clinton formation as will be seen from the section, has a thickness of 713′ exposed; 150′ or 200′ more would reach the *Medina sandstones*.

The Clinton sub-divides here naturally into *Upper Olive shale*, *Fossil ore*, *Lower olive shale*, *Iron sandstones* and *Lower olive slate*.

The uppermost division is mostly made up of sandy and limy shales of a brownish-olive color, containing some fossils, of which *Strophomena alternata*, *S. depressa*, and *Atrypa recticularis* seem to be the most abundant.

The fossil ore has long been extensively mined on the north side of the *Montour axis* to supply the Bloomsburg furnace. The Bloomsburg Iron Co. has a drift on this ore at the mouth of the little run which puts into Fishing creek near J. Neihart's, one mile above Bloomsburg.

The soft ore has all been taken out of this mine, and it is now operating on the "*hard*" or "*block ore*." The original rock is a hard, and rather impure limestone filled with fossils, which near the surface has lost its lime through solution; the iron oxide being left in a *soft*, loose, spongy condition. As the bed gets below the action of surface waters, it passes into "*hard ore*," or "*block ore*," which still contains a large proportion of lime. Still deeper the ore becomes too poor to work.

There are usually two layers of *ore*, a *Big bed* 10″–12″

thick, below which comes about 2′ of impure limestone and shales; then the *Little bed* 2″–4″ thick.

The *Big bed* is reported to be much more persistent than the *Little bed*, though both exhibit frequent irregularities in thickness and quality.

This ore has also been mined along Fishing creek on the south side of the *Montour axis*, just north from where the road crosses that stream to Bloomsburg; but this south dip is steeper and the bed less regular.

On the dump of the Bloomsburg Iron Co.'s mine near Neihart's, I collected the following species which were identified by Prof. Claypole:

Avicula leptonata, *Strophomena depressa*, *S. alternata*, *Atrypa recticularis*, *Rhynchonella robusta*, *R. neglecta*, *Beyrichia lata*, *Calymene clintoni.*

These were obtained in a short time from a very small quantity of material, and the list could certainly be largely increased by a more thorough search in the great heaps of débris at the different ore mines.

The Iron Sandstones which come about 150′ below the *Fossil ore* are of a dark brownish-red color, very hard and contain 10°–20° per cent. of iron, rendering them almost indestructible. They have been quarried quite extensively for *building stone* on both sides of Montour Ridge along Fishing creek, 300′–400′ above the stream on the crest of the axis.

The *Lower Olive slates* are well exposed along the south slope of the *arch*. They are seemingly destitute of fossils and have a pale yellowish-green tinge on the weathered surface.

The axis of the arch crosses Fishing creek almost exactly half way between the Bloomsburg bridge and the forks of the road near H. Neihart's.

From the Bloomsburg bridge, near D. Yocum's, on down Big Fishing creek, that stream flows in the *Bloomsburg red shale* to near the mouth of Hemlock creek, where the *Middle Salina shales and limestones* come down, dipping 30°–35° S. 10° E., where the Rupert road crosses Hemlock creek near J. Baton's.

In passing up Hemlock creek from the Rupert road the *Middle Salina beds* are seen along it for 200 yards, when the *Bloomsburg red shale* comes up and continues along the road to the little stream which puts into Hemlock creek near the next forks in the road, 101 rods from J. Baton's. Here the top of the *Clinton* comes in and the *fossil ore* soon rises above drainage and has long been mined just east from the creek by W. Neal & Sons, for their furnace in Bloomsburg.

As we continue on up Hemlock creek the *fossil ore* rises rapidly and soon shoots into the air over the crest of Montour Ridge. Beyond Ivey's School-house the dip is reversed to the north, and the ore bed comes down again into Hemlock creek where the road crosses the latter above the School-house.

The Irondale mine is operated on the *fossil ore* just below where the road crosses Hemlock creek. The tunnel begins below the *ore* and runs 170 yards before striking it. The ore obtained here is *hard* though the *soft* variety was formerly obtained from workings near the surface.

The Bloomsburg red beds come down along the road north from the Irondale mine, and in their turn pass under drainage near Mr. S. Purcell's; to give place to the *Middle and Upper Salina;* which continue northward to some distance beyond the western branch of Hemlock creek.

Purcell and McBride once opened a bed of limestone in the *Upper Salina* just east from the mouth of West Hemlock, and attempted to burn it, but the rock proved too impure, and would not slake successfully.

The Lower Helderberg limestone is covered up completely on Hemlock creek so that the exact point where it crosses cannot be determined; but a line drawn along its strike in the eastern portion of the township would pass under the northern part of Buckhorn village, and cross Hemlock creek at the old tannery near C. Snyder's.

Its outcrop is also buried from view in this township west from Hemlock creek by the bowlder trash which fills this old *Salina-Hamilton* valley; therefore it is popularly

supposed not to exist; but it is unquestionably present under the trash.

This limestone is last seen on the land of Mr. S. Ohl where it is quarried half way between Little Fishing creek and Buckhorn village, or about two thirds of a mile east from the latter. It furnishes the farmers excellent lime for their lands at this locality, and doubtless would do the same wherever its outcrop could be uncovered.

A bed of limestone 6′ thick was once mined in the *Clinton upper shales*, on the land of Mr. Evans', just east from Wedgetown. It comes about 50′ above the *fossil ore*, is dark blue, and not very pure. Some fragments of fossils were seen in it.

The Chemung beds come in on Hemlock creek at the first forks of road 98 rods north from Buckhorn village, and rise in a prominent ridge both east and west from this point, overlooking the *Hamilton-Salina valley* from an elevation of 300′-400′.

In passing northward up Hemlock creek the Chemung beds are frequently seen dipping 45°-50° north; and this rapid dip continues as far as P. Stroup's. North from the latter locality the dip is reversed, and the rocks pitch southward 30°-40° for some distance; but near Leidy's schoolhouse they turn over and dip 20°-30° toward the north, and this dip continuing the *Chemung-Catskill beds* come down at Kline's mill. At the extreme northern line of the township we come to the bottom of the *Lackawanna syncline* which holds several hundred feet of Catskill rocks.

On the road which passes southward past the Chestnut Grove School-House, the *Chemung-Catskill* rocks seem to end near P. Folk's, for no *red beds* occur south from that point.

The Clinton fossil ore is mined at several localities on the north slope of the Montour anticline west from Hemlock creek, the most extensive mine being operated by Wm. Neal & Sons. The ore crops out at 20-40 rods south from the road which leads westward down the old Salina-Hamilton valley.

The transported bowlders and other trash which cover

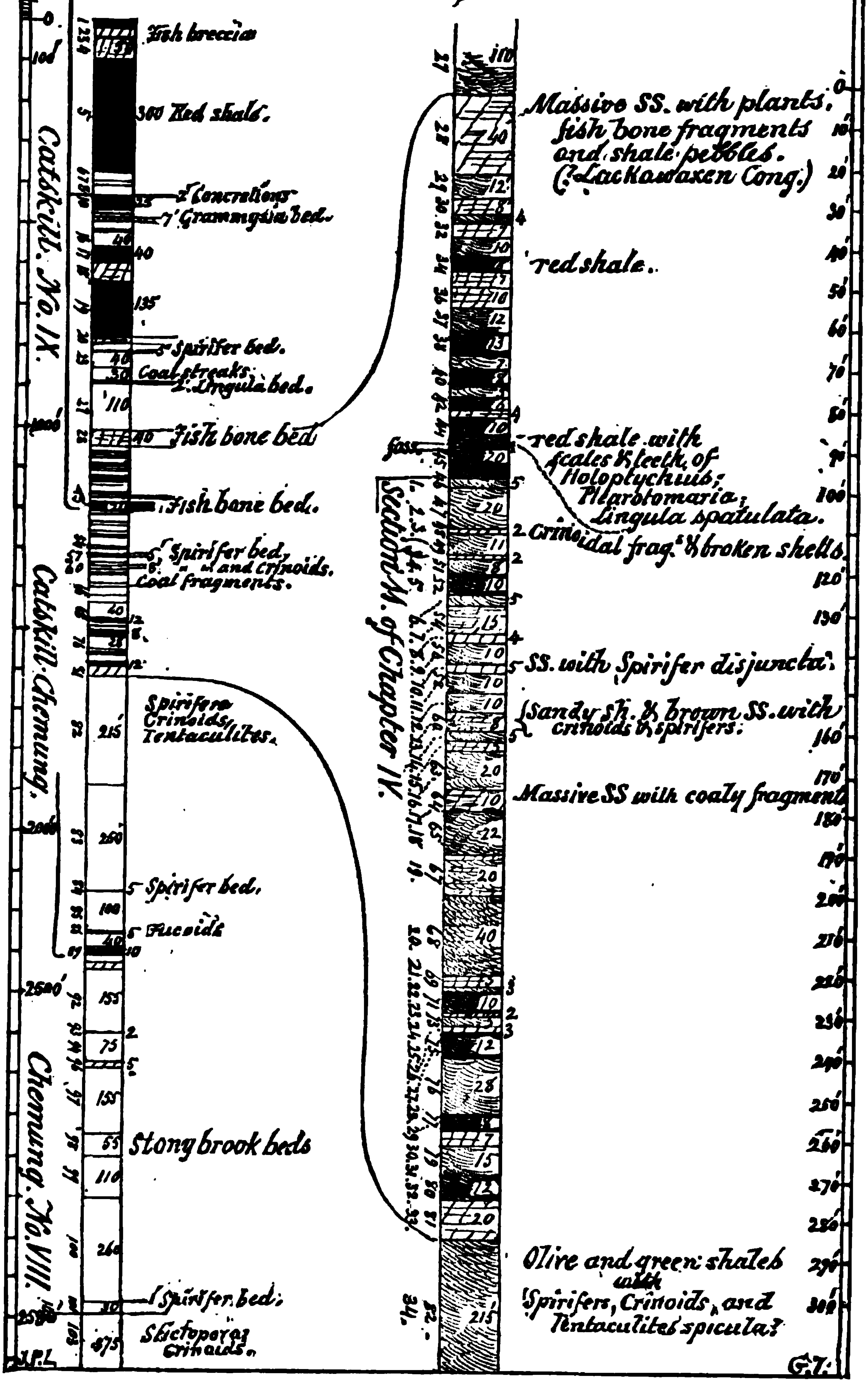
this valley everywhere up to the highest point seen in it (700′ A. T.) are not found on the Chemung and Catskill ridges which rise to an elevation of 950′–1000′ A. T.; showing that these areas were not submerged at the time the bowlder trash was deposited.

Barometric elevations in Hemlock.

	A. T.
Little Fishing creek at crossing east of E. Smith's,	530′
Forks of road 161 rods south of last,	550′
" " " near J. Beagle's,	530′
" " " " A. B. Somer's,	540′
Elbow in road at J. Girton's,	515′
Little Fishing creek at crossing here,	500′
Cross-roads near T. J. Vanderslice's,	495′
Little Fishing creek here,	480′
Junction of Little with Big Fishing creek,	475′
Forks of road at H. Neihart's,	485′
Big Fishing creek at Bloomsburg bridge near D. Yocum's,	465′
Big Fishing creek at mouth of Hemlock creek,	460′
Forks of road near Ivey's School-House,	555′
Hemlock creek at crossing next north,	500′
Forks of road at S. Purcell's,	525′
" " " 32 rods north-west of last,	535′
Hemlock creek at crossing near C. Snyder's,	540′
Cross-roads in Buckhorn village,	580′
Forks of road 98 rods next north,	585′
" " " 80 rods next north,	585′
" " " near P. Stroup's,	600′
" " " near W. Wagner's,	665′
" " " " W. Kline's,	695′
" " " " N. Miller's,	715′
" " " next north, (80 rods,)	745′
Cross-roads near D. Van Horn's,	945′
Forks of road 140 rods east of last,	900′
" " " 121 rods south-east from Van Horn's,	975′
" " " near P. Folk's,	900′
" " " " L. Girton's,	675′
Hemlock creek at crossing 98 rods north from Buckhorn village,	555′
Forks of road just west from Miss H. Kister's,	585′
Forks of road near P. Werkheiser's,	755′
" " " north from J. Springer's,	810′
" " " near P. S. Brugier's,	915′
" " " next north,	975′
Cross-roads near A. Smith's,	860′
Forks of road near M. A. Girton's,	710′
Road at Emmitt's School-House,	695′
Forks of road near D. Purcell's,	645′
Forks of road next east from Dr. J. R. Evans',	590′

Plate XX.

Fig. 67. Catawissa to Rupert. III. X.W. RR.



49. *Montour township.*

This area lies south from Hemlock, along Montour county to the Susquehanna river.

The Montour axis almost exactly coincides with the north line of the township; the *Clinton beds* cropping out at the summit; whence the rocks dip continuously south, *Salina*, *Hamilton*, *Chemung*, and finally *Catskill.*

Salina, *Lower Helderberg*, and *Hamilton* make a wide valley running east and west through the central portion of the township.

The Susquehanna river, after flowing along the strike of the *Hamilton beds* from Hick's ferry to the eastern margin of this township, a distance of 20 miles, suddenly veers southward after receiving Big Fishing creek and cuts squarely through the *Chemung ridge* into the middle of the *Catskill* revealing along its gorge-like passage an almost perfect exposure of the *Chemung* and *transition Catskill-Chemung beds.*

The road which passes along the track of the D., L. & W. R. R. from Catawissa bridge to Rupert station is almost one continuous rock cut; as there was only room for the R. R. track along the narrow shelf which separates the Wyoming canal from the ledges of rock which rise almost perpendicularly 200′-300′ above it, and room was required for a common road bed also, between Catawissa and Rupert stations.

The following section may be regarded as practically exact, since the horizontal intervals were measured by the rails (28′ in length,) of the D. L. & W. R. R., and the exposures are so continuous that the dip could be observed at almost any point in the series:

Section beginning 600′ north of Catawissa station, (Fig. 67, page 236.)

1. *Red shales,*	20′
2. Sandstone, massive, greenish-gray,	20′
3. *Brecciated limestone,* (*fish-bed,*)	5′
4. Sandstone, greenish-gray,	50′
5. *Red shales*, somewhat sandy,	300′
6. Sandstone, greenish-gray,	20′
7. Shales, green, sandy,	10′

8. Sandstone, greenish, massive, ... 30'
9. Greenish, sandy bed containing yellowish, cylindrical clayey masses ½''-1'' thick and 2''-3'' long, ... 2'
10. *Red shales*, sandy, ... 25'
11. Olive shales, ... 10'
12. Sandstone, massive, greenish, ... 10'
13. Green, shaly sandstone containing *Grammysia* sp? and other fossils at base, ... 7'
14. Shales, olive-green, sandy, ... 15'
15. Sandstone, greenish, ... 5'
16. Sandstone, shaly, greenish, ... 40'
17. *Red shales*, ... 40'
18. Sandstones, greenish-gray, some flaggy, ... 50'
19. *Red shales* and sandy beds, ... 135'
20. Green shales and flaggy sandstones, ... 12'
21. Shales, olive-green, ... 15'
22. Sandstone, greenish, flaggy with *Spirifer band* 4'' thick at top containing *Spirifera mesostrialis* and *S. disjuncta*, 5'
23. Shales, olive-green, ... 40'
24. Sandstone, very hard, greenish-gray with *vegetable fragments* and *coaly streaks* in base, ... 30'
25. Olive, sandy shales containing *Lingula spatulata*, *Pteronites chemungensis?* and other fossils, ... 10'
26. *Red shale*, sandy, ... 2'
27. Olive shales with two or three thin layers of hard, greenish, fossiliferous, sandy layers, ... 110'
28. Sandstone, quite massive, containing *vegetable fragments*, *large fish bones*, and *pebbles of shale*, possibly identical with *Lackawaxen conglomerate* of Pike county, . . . 40'
29. Shales, greenish, sandy, ... 12'
30. Sandstone, greenish, massive, ... 8'
31. Shales, olive, ... 4'
32. Sandstone, greenish, flaggy, ... 7'
33. Shales, greenish, ... 10'
34. *Shales, red*, sandy, ... 8
35. Sandstone, purplish-brown, ... 7'
36. " massive, greenish, ... 10'
37. Shales, olive-green, ... 12'
38. *Red shales*, sandy, ... 13'
39. Olive shales, sandy, ... 7'
40. *Red shales*, sandy, ... 8'
41. Shales, green, ... 5'
42. *Red shale*, ... 6'
43. Sandstone, brownish, ... 4'
44. Shales, olive-green, sandy, ... 10'
45. *Red shale*, sandy, containing *scales* and *teeth* of *Holoptychius*, *Pleurotomaria*, sp? and *Lingula spatulata*, in a layer 5' below the top (base of Catskill,) . . . . . 20'
46. Shales, green, sandy, ... 5'
47. Shales, olive, ... 20'
48. Brown sandy bed, containing *crinoidal fragments*, and *shells* much broken, ... 2'

49.	Shales, olive-green,	11′
50.	Sandstone, greenish, contains crinoidal fragments,	2′
51.	Shales, olive-green,	8′
52.	*Shales, purple*, sandy,	10′
53.	Shales, olive-green,	5′
54.	Brown, sandy, flaggy beds,	15′
55.	Brown sandstone, slightly reddish,	4′
56.	Shales, olive-green,	10′
57.	Hard greenish-brown sandstone, containing *Spirifera disjuncta*,	5′
58.	Shales, greenish, sandy,	10′
59.	Shales, olive-green,	10′
60.	Sandy shales and brown sandstones containing *Crinoids* and *Spirifers*,	8′
61.	Olive shales,	5′
62.	Sandstone, green,	5′
63.	Olive shales,	20′
64.	Sandstone, massive, with *coaly* fragments included,	10′
65.	Shales, dark-gray sandy,	22′
67.	Sandstone, green, interstratified with shales,	20′
68.	Shales, brown, and olive-green,	40′
69.	Sandstone, greenish,	5′
70.	Shale, olive,	8′
71.	*Red shale*,	10′
72.	*Red sandstone*,	2′
73.	Shales, olive-green,	5′
74.	*Sandstone, red*,	8′
75.	*Red shale*,	12′
76.	Shales, olive,	28′
77.	*Red shale*,	8′
78.	Sandstone, greenish-gray,	7′
79.	Shales, olive,	15′
80.	*Dark red shale*,	12′
81.	Sandstone, massive, greenish,	20′
82.	Olive and green shaly sandstones with some brownish beds containing *Spirifer*, *Crinoids* and *Tentaculites spicula ?*	215′
83.	Olive shales, sandy,	250′
84.	Brown, sandy shales, filled with a coarse spirifer, probably *S. disjuncta*,	5′
85.	Greenish, sandy beds,	100′
86.	Sandstone, containing *fucoids*,	5′
87.	Concealed,	40′
88.	Shales, olive-green,	5′
89.	*Red* or purple sandy shales exposed at forks of road 280 rods north from Catawissa, and taken as the BASE of the *Catskill-Chemung beds*,	10′
90.	Olive-green, sandy beds,	20′
91.	Sandstone, massive, greenish-gray,	15′
92.	Shales, light olive-green, no fossils seen,	155′
93.	Sandstone, very hard, bluish,	2′
94.	Greenish, shaly, sandy beds,	75′

96.	Sandstone, rather massive,	15′
97.	Green, and olive, and yellowish sandy beds, sparingly fossiliferous,	155′
98.	*Stony Brook beds*, filled with *Leiorhynchus mesocostale*, *Productella hirsuta* and *Spirifera disjuncta*, besides many others,	55′
99.	Greenish, sandy beds, fossiliferous,	110′
100.	Olive, and dark-greenish, sandy beds, shaly above but more massive below,	260′
101.	*Spirifer band*, containing *S. mesostrialis*,	1′
102.	Dark-green, sandy beds,	30′
103.	Dark-olive, very hard, sandy beds containing *Stictopora* and *Crinoidal stems* to run near I. Monroe's,	375′
104.	Olive, green, and bluish sandstones and sandy shales to base of *Chemung* opposite Canal bridge at Rupert Station,	1175′
105.	*Genesee* black and bluish slates,	125′

If we place the beginning of the *Catskill beds* at the lowest stratum in which *Holoptychius* was seen, viz: No. 45, and then summarize the section, the following intervals are obtained:

IX.	*Catskill* Nos. 1 to 45,	1209′
VIII.	*Catskill-Chemung*, Nos. 46–89,	1007′
	Chemung, Nos. 90–104,	2443′
	Genesee shale, No. 105, visible	125′
		4784′

Chemung fossils found in Catskill rocks:

The most interesting thing shown by this section is the fact that some of the fossils usually regarded as characteristic of the *Chemung* are found here far up in the undoubted *Catskill*. For instance, a form which Prof. Claypole (who identified the fossils given in the section) could not distinguish from *Grammysia elliptica* occurs at 700′ above the *Holoptychius bed* (No. 45) or 1700′ above the *lowest red bed.*—*Spirifera disjuncta* and *S. mesostrialis* occur 375′ above the *Holoptychius bed* or 1375′ above the *lowest red bed.*—*Pteronites chemungensis* and *Lingula spatulata* occur only 75′ lower down; i. e. 1300′ above the *lowest red bed.*

But the marked absence of other well known *Chemung* fossils shows that the above mentioned species are merely five species which survived, long beyond those with which they are associated in the genuine *Chemung beds*, into the *Catskill age.*

The rocks of this section all dip south about 10° east at an angle of 45° through the *Chemung*, and most of the *transition beds;* then it falls off to 40°, and finally becomes only 30° at the top of the exposed beds.

No. 28. The massive sandstone, filled with *fish-bones* and *vegetable fragments* is of pecular interest since it seems to be identical with the *Lackawaxen conglomerate* of Pike county; a rock which is locally conglomeratic on the Delaware river, being the lowest bed in the *Catskill* that ever becomes a *regular conglomerate* in Pike and Monroe. In the township next west from Montour, it is a mass of *quartz pebbles* and *fish bones.*

No. 45. This is the only locality in the district where the *transition* between *Chemung* and *Catskill* can be studied in complete detail; for, the presence of *Holoptychius* in No. 45 fixes there the beginning of the *Catksill series;* the rocks below No. 45 were searched with great care for *Holoptychius remains* but in vain.

No. 91. *The Falls creek conglomerate* of Bradford county, seems to be represented by No. 91, a massive sandstone which makes a bold cliff, but is not pebbly at this locality, though it is in other portions of the region.

No. 98. *The Stony Brook beds*, are here very fossiliferous, being filled with typical *Chemung fossils*, and especially rich in *Productella*, *Leiorhynchus*, and *Spirifera.* The beds have a greenish, olive cast and are rather shaly. The same fossils occur about 100′ above and below No. 98, but in much diminished numbers; so that I have confined the name *Stony Brook beds* to the most fossiliferous portion.

No. 100. There begins here a series of hard, sandy beds, of dark gray and dark olive-green color, which weather into splintery fragments when broken by the frost and make cliffs along the hills. They contain a species of *Stictopora* in great abundance in the upper two thirds, and two or three horizons rich in fossil *mollusks.* The rocks have much the same lithological aspect throughout the entire 1800′, down to the base of the Chemung.

No. 105. *The Genesee* comes up nearly opposite Rupert Depot, and is quite well exposed to 200′ north from the

Plate XXI.

Fig. 68. Mauser's Qy.

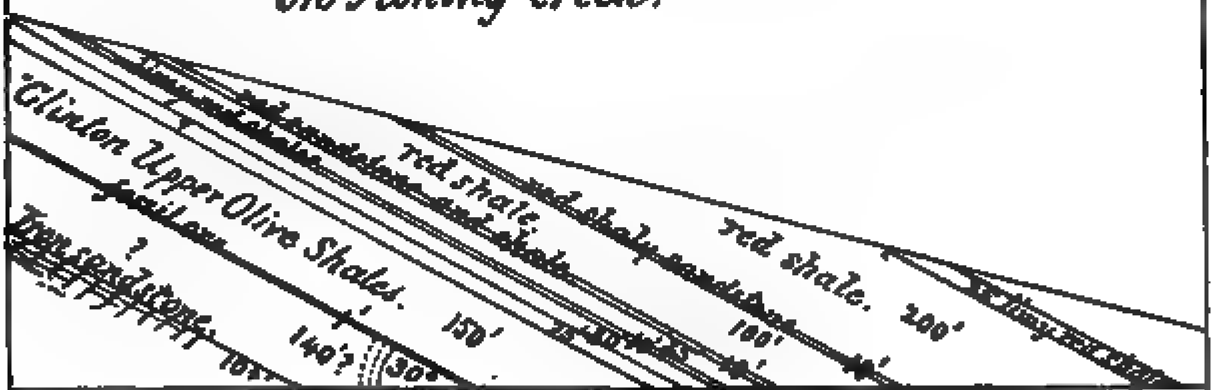
Fig. 69. Eck's Quarry.

Fig. 70. Mensch's Qy.

Lower Helderberg No. VI.

Fig. 71. Bloomsburg terrace.

Fig. 72. Bloomsburg Iron Co's RR. section. on Fishing creek.



J.P.L.

G.7.

same; then the surface accumulations cover up its outcrop. The top of this series is seen, however, in the bed of Big Fishing creek just under the aqueduct over which the Wyoming canal crosses that stream; and, as this is nearly 300′ north from the lowest exposed portion of the Genesee given in the section, it would indicate (since the dip is 45°) a thickness of about 300′ for the entire *Genesee group*.

At Catawissa station the Susquehanna river sweeps around to the westward out of its southward course, and thenceforward follows rudely the strike of the *Catskill rocks* along the southern margin of this township.

In passing northward from the Susquehanna river along the road which separates this township from Montour county we go through the lower portion of the *Catskill beds*, and see the green, flaggy sandstones of the *Catskill-Chemung* with an occasional thin red bed cropping out along the run until we come to the mouth of the little stream which flows eastward into Arying's run, one half mile north from the D. L. & W. railroad. Here, a few yards above its mouth, the *lowest red bed* or base of the *transition VIII–IX series* crosses the road and we enter a remarkable gap through a high, bold ridge, cut at the head of Arying's run along the north and south road. This gap is cut down more than 100′ below the general level of the *Chemung ridge*, both east and west from it, and rounded bowlders of *sandstone*, *limestone*, *chert*, *Salina red shale*, and *Clinton fossil ore* occur on its summit, and along its north and south slopes.

This fact seems to me to suggest that the "gap" was eroded by a stream in the past which flowed southward into the Susquehanna valley from a new buried valley which bounds the Chemung ridge on the north.

This buried valley along the strike of the *Hamilton* is a continuation of the Susquehanna valley; and it looks as if the Susquehanna once flowed along it from Rupert to Danville, 7 miles, where it debouches into the present Susquehanna.

The *Hamilton beds* underlie the old valley throughout the entire length of this township; and are everywhere con-

cealed, except at one or two cuts along the Catawissa R. R. and on Big Fishing creek in the vicinity of the D. L. & W. R. R. bridge.

The Oriskany sandstone, a series of cherty, limy, and sandy beds, rises out from under the northern edge of the Hamilton valley and forms a low escarpment nearly parallel to and almost exactly coincident with the Danville and Bloomsburg road; though its outcrop is continually covered up, except in one or two places, by the great heaps of transported bowlders and trash which line the old valley.

The Stormville shale comes up under the *Oriskany*, but is covered up at every locality in the township, except one, where it makes a dusky black outcrop across the road just south from I. Mowry's. It seems to contain a considerable amount of *black slate*, or shale, and the entire series is probably 75'-100' thick.

The Lower Helderberg limestone makes a low ridge through the township bounding the northern side of the Hamilton valley and separating it from the Salina valley next north. It is quarried at several places in the township, and we shall now describe the principal of these, beginning at the west and going eastward.

The first quarry is about one half mile east from the western boundary and is known as the Mauser quarry. At that locality the following section is revealed at the numerous excavations and cuttings made in quarrying:

Mauser's Quarry, (Fig. 68, page 242.)

1. Soil,	5'
2. Limestone, shaly and flaggy, bluish,	10'
3. *Stromatopora bed*, a massive, bluish-gray limestone composed almost entirely of *Stromatopora concentrica*,	12'
4. Limestone, shaly, bluish,	5'
5. Limestone, massive, gray, containing vast quantities of *Halysites catenulata*, [☞NIAGARA,]	20'
6. Limestone, rough, gray, somewhat crystalline, a mere mass of Crinoidal fragments, broken shells, and a coral very much resembling *Cladopora multipora*,	12'
7. "Bastard limestone," a buffish impure magnesian bed, containing *Beyrichias*, *Strophomena rugosa*, *Atrypa recticularis*, and very probably representing the Stormville Cement beds of Pike and Monroe counties,	20'

8. *Bossardville limestone:*		
(*a.*) Dark-blue or blackish limestone in thin, flaggy layers, much streaked with calcite; the purest bed in the series, known to the quarrymen as the "main bench,"	35′	110′
(*b.*) Shaly limestone, dark-blue, the layers only ¼″–1″ thick, impure,	35′	
(*c.*) Flaggy limestone, dark-blue, quite good,	30′	
(*d.*) Shaly limestone, bluish-gray to bottom of exposure,	10′	
Total thickness of limestone measured,		189′

No. 2. A line of cherty sandstone bowlders 20′–25′ above the top of No. 2, marks the presence of the *Stormville conglomerate horizon* of Pike and Monroe.

A well just below the base of the *Bossardville beds* brought up the impure buffish and pale green beds of the *Salina.*

Therefore if we add 25′ to the top of the section and 10′ to its base we should have about 224′ for the entire thickness of the *Lower Helderberg limestone* at this locality exclusive of the *Stormville shales;* including these would raise the thickness to 300′.

No. 3. *The Stromatapora bed* is certainly identical with the stratum noted in the *Stormville limestones* of Pike and Monroe which contained so many *Stromatoporæ;* and its occurrence here gives an unmistakable and valuable horizon for correlating the beds of the Monroe county *Lower Helderberg* with that of Columbia and Montour. This stratum is one great reef of *Stromatopora concentrica* which stands out from the weathered cliff in masses 2″–18″ in diameter.

No. 5 is much the most interesting bed of the series, for in it I found *Halysites catenulata* covering the surfaces with its beautiful chain-like tubes, and forming in some portions of the bed quite as large a part of the rock as the *Stromatopora* does in No. 3. The occurrence of *Halysites catenulata* in the undoubted *Lower Helderberg* here, is most interesting, from the fact that it has always been regarded as perfectly characteristic of the *Niagara period;* but here we find it surviving to near the close of the *Lower Helderberg period*, which overlies more than 1000′ of *Salina beds.*

Both Nos. 3 and 5 are quarried and burned by Mr.

Mauser, making good strong lime for agricultural purposes, but not sufficiently white for plastering.

No. 7 is called the "*bastard limestone*" by the quarrymen, from the fact that it is too impure to be used for burning, and hence is always rejected. It is of a buffish tint, generally, but occasionally an ashen-gray, sparingly fossiliferous, quite tough and used sometimes for building stone. This bed is persistent for nearly 20 miles across Columbia county; and since it is somewhat magnesian and comes at the same horizon as the *Stormville cement bed* of Pike and Monroe, I have identified it with the latter, although the *Decker's Ferry sandstone* and *shales* come at the same horizon.

No. 8. *The Bossardville limestone* of Pike and Monroe is perfectly represented by No. 8 (a, b, c, d,) in structure, in lithology, and in every other respect. There can be no doubt whatever of the correctness of the identification, for the *Salina* buff and pale green limy shales come immediately below No. 8, as the same *Salina* (*Poxono*) *beds* do in Monroe.

(a). The upper division of the Bossardville limestone is the purest portion of the whole *Lower Helderberg limestone*, and is usually quarried out entirely before any of the other beds are touched. It makes an excellent lime for plastering, and all building purposes, and is in high repute as a fertilizer.

The rocks pitch S. 10° E. 30°–40° at this quarry.

North from here the *Salina beds* make a wide valley until the *Clinton beds* come up and the *Iron sandstone* carries the surface abruptly up to the summit of Montour Ridge, at the northern line of the township 400′–500′ above the *Salina valley*.

Appleman's quarry. Just east from Mauser's the Main Bench (8^a) of the *Bossardville limestone* has been extensively quarried by Mr. S. Appleman who has confined his operations entirely to that bed, and mined it to a depth of 30′ for more than one fourth mile along the strike; the heavy bed of "*bastard limestone*" preventing access to the *Stormville limestone* above it without expensive cuttings through

the former since the rocks pitch southward at an angle of 40°.

A bed of cherty sandstone 4′-5′ thick and containing *Spirifera arenosa* is seen in descending Appleman's run from his quarry to the Danville road. It comes directly beneath the dark *Stormville shale* and is very probably identical with the *Stormville conglomerate* of Monroe Co.

Eck's quarry is about one half mile east of Appleman's.

Charles Eck quarry (*Fig. 69, page 242.*)

1. Soil,	2′-5′
2. Limestone, bluish-gray,	8′
3. *Stromatopora bed,*	10′
4. Limestone, bluish-gray, very fossiliferous, containing *Favosites, Zaphrentis, Stromatopora, Crinoidal* fragments, and other fossils,	20′
5. Limestone, slaty, dip S. 15° E. 38°,	5′
6. *Bastard limestone,*	15′
7. Dark blue, flaggy limestone, "main bench" best in quarry,	20′
8. Bluish-gray, shaly, flaggy limestone, full of *Leperditia alta* for 10′-15′ at top, layers only ½″-1″ thick,	30′
9. Bluish-black limestone, more massive,	15′
10. Shelly limestone,	5′
11. Limestone, bluish-gray,	1½′
12. Shelly limestone, bluish-gray to base of exposure,	2′

No. 3. *The Stromatopora bed* is here, as at Mauser's, a mass of *Stromataporæ* and other corals, many of which are beautifully weathered out of the matrix.

No. 4 is also very fossiliferous at this locality, though the *Stromatoporæ* are much less abundant than in No. 2. *Crinoidal fragments* and a species of *Cladopora*, a delicate branching form, seem to be the most numerous. *Atrypa recticularis* also occurs here. Both Nos. 2 and 4 have been quarried and burned at this locality, but No. 7, the top of the *Bossardville series*, is the one mostly quarried since it furnishes the purest lime.

No. 6. The "bastard limestone," has its usual buffish-gray tint, and is full of minute fossils which are probably *Beyrichias*.

The Bossardville beds are represented by Nos. 7-12, which do not, however, include all of that series, since

30′–40′ are concealed below the base of No. 12, the lowest layer exposed.

No. 8 is filled with *Leperditia alta* in its upper half; they cover the thinly laminated layers by the thousand.

The top of the *Lower Helderberg limestone* at Eck's quarry comes up to the surface on a rapid (40°) south dip at 200 yards north from the Bloomsburg and Danville road.

Drift. A little east of Mr. Charles Eck's, the gravel and bowlder deposits which fill the old Hamilton buried valley are seen extending up to a level plain at 615′ A. T. or 165′ above the Susquehanna river at the mouth of Fishing creek, one mile east. In these deposits are found small, rounded bowlders of *granite*, *gneiss* and other *igneous rocks*.

These gravel and bowlder trash deposits are also seen at school-house No. 1, making a great bank along the road, and completely concealing all the stratified rocks.

The next quarry in the *Lower Helderberg limestone* is about ¼ mile east from school-house No. 1, on the land of Mr. J. S. Mensch, and is one of the oldest in the county, having been operated for a period of more than 60 years.

The following section is exposed:

J. S. Mensch's quarry (*Fig. 70, page 242.*)

1. Soil and yellow loam,	10′–15′
2. Limestone, bluish-gray, full of Crinoidal fragments and other fossils,	6′
3. Shaly, gray limestone,	5′
4. Bastard limestone,	30′
5. *Bossardville limestone*, bluish-black, thin layers of very good limestone veined with much calcite, . . . visible	25′

Nos. 2 and 3 have been quarried to a small extent, but No. 5 furnishes the principal quarry rock. In the *bastard limestone* which has an unusual thickness here, were seen *Atrypa recticularis*, *Beyrichia*, sp? *Strophomena depressa*, and *Rhynchonella formosa*.

The top of the *Bossardville limestone*, No. 5, has been quarried out along the hills in both directions (east and west) under the massive *bastard limestone* which overhangs the excavations, dipping southward at an angle of 35°–40°.

Evans' quarry. East of Mensch's the *Helderberg limestones* are covered up until we come to Big Fishing creek, just east from where the Bloomsburg road first strikes its banks, and turns north near I. M. Evans'. Here this limestone comes out from under a great bed of coarse, reddish sand, and extends in a solid wall 5′–6′ high, nearly across the creek. The limestone has been quarried here along the stream, by Mr. Evans, where about 50′ of the rock are exposed, seemingly the lower portion.

Cleavage. The lower part exhibits a rude *cleavage*, and also *columnar* (slylolites) *structure* at a high angle to the north, thus giving the bed the appearance of dipping in that direction; but the true dip is S. 15° E. at the rate of 25°–30°.

A bed of trash consisting largely of reddish sand showing lines of stratification rests on the limestone and extends upward to the top of the steep bluff 50′–60′ above the level of Fishing creek. It has been derived principally from the waste of the *Catskill* and *Pocono rocks.*

As we go northward from the last locality everything is covered up by the surface deposits of sand and bowlders until we come to the township line at the crossing of Hemlock creek, where the *Salina beds* are uncovered and we see a series of pale green, limy shales and impure limestones alternating with red shales. On passing up Hemlock creek the *Bloomsburg red shale* or basal member of the *Salina* comes up; and then the *Clinton*, with its *fossil iron ore*, 125′–150′ below its top, comes to the surface about one fourth mile south from the northern line of the township.

Here the *ore* was once extensively mined on the land of Mr. Giger, one mile and a half west from Big Fishing creek.

Barometric elevations in Montour.

		A. T.
Big Fishing creek at mouth of Hemlock,		460′
Forks of road near I. M. Evans',		490′
" "	at School-house No. 1,	550′
" "	next west of last,	535′
" "	near M. S. Appleman's,	580′
" "	at south-western corner of the township,	475′

Forks of road near G. W. Arying's,	510'
" " 327 rods north of last,	730'
" " 38 " "	745'
Summit in gap 10 rods south of last,	755'
Catawissa and Williamsport R. R. at western line of Montour township,	600'

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50. *Bloomsburg township.*

This area lying in the angle formed by the Susquehanna river and Big Fishing creek, includes the town of Bloomsburg, the county-seat of Columbia county.

The *Montour* axis passes across the northern half of the township, crossing Big Fishing creek just north from the Bloomsburg Iron Co.'s furnace. It hoists the *Clinton fossil ore* into the air on the crest of *Iron sandstone* Montour ridge.

The rocks dip rapidly both north and south.

The *Salina* beds nearly all pitch under before the furthest point of the township is reached on Big Fishing creek.

South from the *Berwick axis* the *Clinton*, *Salina*, *Lower Helderberg*, and *Hamilton formations* come down, the latter extending to the south shore of the Susquehanna where the top of the *Hamilton* proper is nearly under water.

The Susquehanna river and Big Fishing creek have carved out a wide plain in (the vicinity of their junction) from the soft rocks of the *Salina-Hamilton*, and the area thus eroded (2½ miles long by 1½ wide) is now covered by a vast deposit of sand and gravel in successive terraces; the town of Bloomsburg occupies the principal portion of the uppermost.

Top of 3d terrace at 65'–70' above the level of the Susquehanna river and 520' A. T.

From the top of the 3d a sudden slope goes down to the top of another broad level area at the level of the D., L. & W. R. R. station or 490' A. T.

Then another descent over a steep escarpment carries the surface down to a very wide level stretch 20' lower which forms the present flood plain of the Susquehanna river and

Big Fishing creek at an elevation of 470′ A. T or 20′ above low water in the river opposite Bloomsburg.

On the Fishing creek side the *2d terrace* is absent, and there is an almost precipitous descent of 50′ from the top of the 3d to the 1st.

A thick bed of reddish-white sand is found covering the top of the 3d terrace to an unknown depth. It has long been extensively mined and used for plastering and other building purposes. A tolerably good exposure of the upper portion of the slope leading down from the 3d terrace was seen at the side of 5th street in Bloomsburg, on the land of Rev. J. B. Waller, where the section is as follows:

Section of 3rd terrace escarpment in Bloomsburg (Fig. 71, page 242.)

1.	Yellowish loam (soil,)	4′–8′
2.	Sand, reddish-white and brown, stratified, exhibiting current-bedding, and enclosing small, rounded pebbles ½″–2″ in diameter, elevation at base 500′ A. T., ...	15′
3.	Bed of small rounded bowlders and gravel going down for several feet, bottom not known, explored for a depth of	5′

No. 2. This bed of sand has been explored at many localities around Bloomsburg and seems to be quite persistent at the level above given. This is the same bed as that noted near Mr. Evans', in Montour township, on the west bank of Fishing creek; and it seems probable that the latter stream was the principal agent in transporting the sand, since the latter is just such material as the coarse sandstones of the *Pocono-Catskill* and *Pocono* would furnish.

These surface deposits completely cover up the *Lower Helderberg* and *Oriskany beds* through this township, though the line of their outcrop would run not far from the D. L. & W. R. R. through the borough.

The following section is seen in passing along the R. R. of the Bloomsburg Iron Co. where it enters the *red shale cutting* at the north line of Bloomsburg:

Section along Bloomsburg Iron Co.'s R. R. on Fishing creek (*Fig. 72, page 242.*)

1.	Red shale, somewhat streaked with their calcareous shales (dip S. 15° E. 30°,)	Bloomsburg red shale.	25'
2.	Red shales,		200'
3.	Red, shaly, sandstone,		5'
4.	Red shale,		100'
5.	Red sandstone and shale,		10'
6.	Red sandy shale,		35'
7.	Red shales, mottled with pale-green, with thin limy layers,		10'
8.	Red sandy shales,		30'
9.	Concealed,		25'
10.	*Clinton*, olive (upper) sandy and limy shales and flags,		150'
11.	*Clinton fossil ore*,		1'
12.	Concealed,		140'
13.	*Iron sandstone*,	visible	10'
			741'

The *Bloomsburg red shale* I have named from this locality where it presents so fine an exposure along the banks of Big Fishing creek.

No. 9. The concealed portion is mostly red shale, and hence the thickness visible in this section is 440'; and, as No. 1 begins a few feet below the top of the *red beds* we may safely put the entire thickness in the vicinity of Bloomsburg at 450'. Much of this red shale is somewhat sandy; and this causes it to rise in a steep bluff from the bed of Fishing creek to more than 100' above, compelling the Bloomsburg Iron Co. to make a clean cut through it to get a bed for their railroad.

No fossils were observed in these red beds, though I did not make a minute search for them.

The Upper Olive shales are fossiliferous at this locality, and contain *Atrypa recticularis*, *Strophomena alternata*, and *Rhynchonella robusta* in large numbers at some of the horizons. The beds are more flaggy sandstones than shales, and a few of the layers are quite limy at 40'–50' above the *fossil ore*.

The fossil ore has been mined to some extent along through the fields just east from Fishing creek, and used at the Bloomsburg Iron Company's furnace near by.

No. 13. *The iron sandstone*, is a reddish-brown, very hard stratum which juts out in a cliff along the hill as it rapidly rises toward the crest of the ridge which it makes.

The fossil ore arches into the air over this ridge, and descending to the north comes down to the surface along the road which runs east and west one half mile north from the Bloomsburg furnace where it has also been mined in the past.

The Salina beds underlie Bloomsburg, and the deep wells which pass through the surface deposits enter the red shales and alternating beds of pale green magnesian limestone which make up the main bulk of that group above the *Bloomsburg red shale.*

The Hamilton beds are covered up under the great heaps of surface material which extend from the D., L. & W. R. R. at Bloomsburg south to the Susquehanna river, except at one or two points where cuttings along the road expose them. One of these outcrops on the road that leads down to the canal from the Bloomsburg Iron Company's R. R. shows grayish-yellow shales just north from the canal, dipping 40°, south 10° east. These *Hamilton rocks*, (*Marcellus* and *Hamilton* proper) cover a belt 4200′ wide; for they stretch southward to about 50′ beyond the southern bank of the Susquehanna river; and if we place the average dip at only 30° the resulting thickness of the whole *Hamilton group* (calling the *Tully* and Marcellus 300′) would be 2400′, or more than double what it is on the north side of the *Montour axis* in Hemlock township, only three miles distant. True, some unknown *anticlinal* may run through the concealed portion and thus spread out these beds into the much wider belt that they occupy here, but this is not probable since its presence is not indicated in any other portion of the district.

The hard sandy beds of the *Hamilton* proper stand up from the channel of the Susquehanna river in long, low ridges of rock, skimming along 1′–3′ above the surface at low water, diagonally, across the stream, and interrupted by frequent gaps where the projecting ledges have been abraded below water level. These beds dip south 10° E. 35°–40°, and

Plate XXII.

Fig. 73. Creveling's

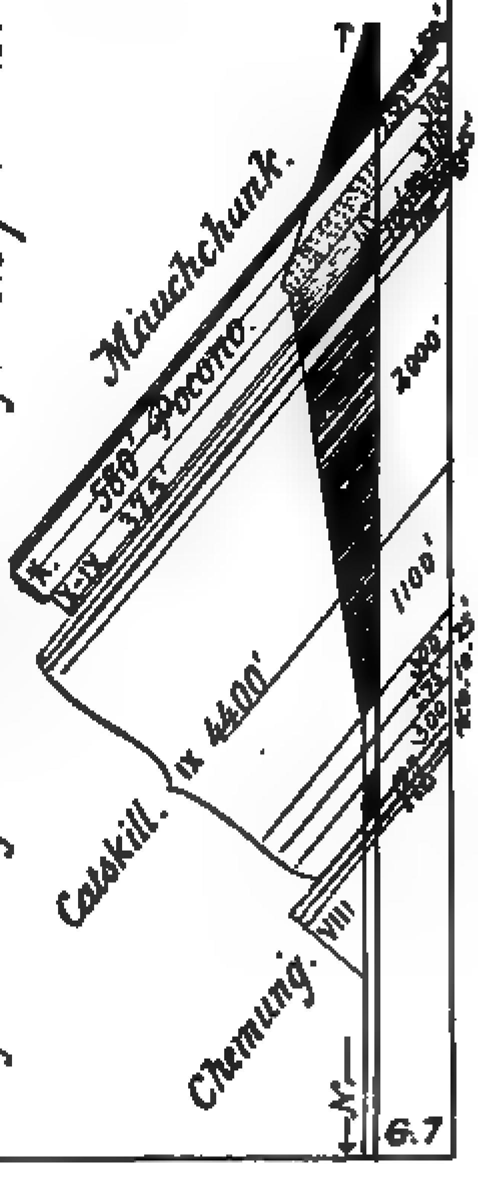
Fig. 74. Boon's Quarry

Fig. 75. Low; Brother's

Lower Helderberg. No. VI.

Fig. 76.
Lime Ridge St.

Fig. 77. Along Cattawissa Cr. through Nescopec Mtn.



J.P.L.

the harder ones extend from the southern shore almost to the northern one, where they seem to be suddenly cut off, as though an older and deeper channel had been worn through them there; though the soft shales exposed on the banks of the canal just north would seem to forbid the existence of any deeply buried channel of the Susquehanna in this vicinity.

Barometric elevations in Bloomsburg.

	A. T.
Susquehanna river at mouth of Fishing creek, ...	450′
Susquehanna river at Bloomsburg ferry, ...	451′
Fishing creek at road crossing near mouth of Hemlock, . . .	460′
Fishing creek at bridge in northern portion of Bloomsburg, .	465′
Fishing creek at junction with Little Fishing, ...	475′
Fishing creek at crossing of road next east of last, ...	480′
2d street, Bloomsburg, opposite the Exchange Hotel, ...	520′

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51. Scott township.

This township lies next east from Bloomsburg along the river.

Big Fishing creek flows along the western portion of its northern border.

The Montour axis passes almost directly through the center of the township and elevates the *Clinton rocks* into a long ridge, rapidly declining eastward. At the western line of the township *the fossil ore* is thrown into the air and the *Iron sandstone* makes the arch of the ridge at an elevation of 900′ A. T., while at the eastern line of the township the *fossil ore* is not brought to daylight on the crest of the arch at 750′ A. T.

This rapid declension in the height of the ridge is due to the fact that the *Iron Sandstone* is replaced by the soft beds of the lower portion of the *Salina.*

Thus the *Salina* and upper *Clinton beds* make a broad belt dipping both north and south on either side of the *Montour axis* through the center of the township, bordered the *Lower Helderberg* narrow outcrop.

The Hamilton beds cover the extreme northern portion;

while on the south they extend to the southern shore of the Susquehanna river.

The Clinton fossil ore was once extensively mined on both sides of the Montour ridge in this township, on the lands of Messrs. Kressler, Sankey, Bartram, Krumm, and others, but the best of the *ore* within easy reach from the surface has been exhausted, though it is still mined on a small scale by Mr. Sankey.

The *Hamilton*, *Lower Helderberg*, and upper portion of the *Salina beds* make a wide valley across the northern portion of the township, buried with bowlder trash to a great depth, if one may judge from appearances; since no outcropping rocks are anywhere to be seen within this valley, except where Fishing creek cuts into its center near the western line of the township, in the vicinity of the Paper Mill. There the *Lower Helderberg limestone* occurs in a low ledge on the south bank of the stream, and has been quarried to a small extent.

The town of Light Street is situated in the center of this old buried valley on a heap of rounded bowlder trash at an elevation of 530′ A. T.

In passing south from Light Street vast heaps of rounded *Pocono*, *Catskill*, *Chemung*, and other bowlders occur up to the summit between Fishing creek and the Susquehanna river at 675′ A. T. near J. W. Vanderslice's. These transported bowlders are also seen, as we go eastward along the crest of the Montour ridge, up to 800′ A. T., many of them resting on the highest summits. Some are angular and 2′–4′ in diameter.

These large bowlders of angular *Pocono conglomerate* are especially numerous on the very summit of the divide between the Susquehanna and Fishing creek valleys at 720′ A. T. just north from J. Heckman's.

On the south side of the anticlinal the *Lower Helderberg limestone* comes down on a rapid south dip only 4–5 rods north from the D., L. & W. R. R., and its strike is almost exactly parallel with this road all across the southern portion of the township.

Mr. G. W. Creveling has a large limestone quarry in the

Lower Helderberg beds at the west line of this area and just north from the D., L. & W. R. R. where the following succession is exposed:

Creveling's quarry, (Fig. 73, page 254.)

1.	Blue shaly limestone,	15'
2.	Impure ochrey magnesian limestone,	7'
3.	Dark blue shaly limestone,	13'
4.	Limestone, dark gray, rough with many fossils, some *Stematoporæ*,	20'
5.	"Bastard limestone,"	15'
6.	Blue limestone,	25'
7.	Blackish-blue limestone to bottom of the layers quarried,	25'
		125'

The rocks pitch S. 15° E. here at an angle of 45°–50°.

The Stromatopora bed seems to be represented in the upper portion of No. 4, though the number of *Stromatoporæ* visible in this stratum is much less than occur in it in Montour township 8 or 10 miles west from here.

The "Bastard limestone" of Montour is still persistent here, having the same peculiar buffish-gray color and general aspect that it has in the latter township.

Nos. 6 and 7 are portions of the *Bossardville limestone*, the bottom of which is not visible at this locality. They are quite pure and furnish the main quarry limestone; though a considerable portion of No. 4 is pure enough for use.

A few rods west from the Creveling quarry the same beds are mined by Mr. Aaron Boone, and there the following structure is visible:

Boone's quarry, (Fig. 74, page 254.)

1.	Limestone, hard, bluish-gray,			12'
2.	"Bastard limestone,"			12'
3.	Limestone, blue,	25'	Bossardville limestone.	95'
4.	" dark blue, thin-bedded,	20'		
5.	" bluish-gray, "	20'		
6.	" dark blue, more massive,	30'		
7.	Buffish, impure, shaly limestones with a magnesian look and very probably belonging to the *Salina*,			
				119'

This section goes down to the base of the *Bossardville*

limestone which is here nearly 100′ thick, having the same bluish cast and thin shelly layers that characterize it everywhere.

The uppermost portion of the *Lower Helderberg* is concealed here, since it dips down under the terrace deposits and has never been uncovered.

Much limestone is shipped from these quarries to the furnaces at Bloomsburg and Danville, and large quantities are burned into lime and sold for building and fertilizing purposes.

As we pass west from Boone's there are one or two other small quarries, and then the *Lower Helderberg limestone* which makes a ridge 50′–75′ high at Creveling's and Boone's suddenly sinks from sight to the general level of the broad terrace on which the D. L. & W. R. R. runs, and leaves only a low bluff of the magnesian beds of the *Salina* bounding the northern wall of the plain. It has evidently been eroded below the general level of the plain, and could certainly be found by digging down through the surface débris, although the land owners regard it as absent entirely.

The basal members of the *Lower Helderberg beds* come up again above the detrital-covered plain one half mile east from Espy Station, and are there quarried by Messrs. Creveling, Martz & Co. Only 30′–40′ of the *Bossardville limestone* come into the bluff while the entire upper portion remains below the plain.

A short distance north-west from the last locality the same beds have been quarried along the road near Thos. Creveling's; and below them occur the buffish-green beds of the *Salina*, dipping S. 15° E. 35°. These beds continue northward along the road half way to J. Heckman's when *red beds* alternating with greenish limy shales and impure limestones (Middle Salina) come up, and crop out along the road for several yards.

In passing westward from Espy, the *Lower Helderberg limestone* is constantly buried beneath the broad plain, covered with bowlders and other detrital material which borders the Susquehanna, and is seen no more until we pass

through Bloomsburg township and reach Fishing creek at the eastern edge of Montour. It is not absent, as generally supposed by the farmers, but its outcrop buried under the deposits probably too deep ever to be successfully quarried.

Barometric elevations in Scott.

	A. T.
Cross-roads at eastern line of the township just north from the D. L. & W. R. R.,	500′
Crossing of run next north,	565′
Cross-roads near Chas. Schug's,	750′
1st elbow bend in road east from here,	720′
2d elbow bend in road east from Schug's,	720′
Forks of road next north from J. Heckman's,	720′
" " " near J. Heckman's,	680′
" " " " Thos. Creveling's,	510′
Cross-roads 189 rods west from last,	680′
Forks of road next north-west,	680′
Cross-roads near J. W. Vanderslice's,	700′
Forks of road near tannery,	525′
Cross-roads in Light Street,	530′
Forks of road near F. P. Kelly's,	530
Level of Fishing creek just opposite,	510′
Forks of road west from G. Cigler's,	795′
" " " 120 rods north-west of last,	810′
By-road to Valentine Kressler's,	785′
Susquehanna river at Espy,	455′

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52. Center township.

This area lies next east from Scott, and borders the Susquehanna river on the south, into which all of its drainage passes except from the extreme western portion which drains into Fishing creek.

The section of the rocks is much greater than in Scott, extending northward to the crest of *Huntington mountain.*

The Montour axis enters this township from Scott just south from Chas. Lee's, and brings the *Bloomsburg red shale* to the surface in a gentle arch.

The Lower Helderberg limestone has steep dips both north and south, and along the D., L. & W. R. R. makes a high bluff known as Lime Ridge where it has long been extensively quarried.

The following section is exhibited at the quarry of the Low Bros., a short distance below Lime Ridge station:

Low Bros.' quarry, (Fig. 75, page 254.)

1.	Limestone, bluish-gray,	5'
2.	Shaly limestone and limy shales, gray,	10'
3.	Limestone, bluish-gray, shaly,	8'
4.	Limy shales,	2'
5.	Shaly limestone,	3'
6.	Limestone, blackish, full of *Leperditia alta*,	5'
7.	Drab, sandy shale, [Stromatopora bed?)	6'
8.	Dark blue limy shale,	6'
9.	Limestone, bluish-gray and dark,	25'
10.	Rough, curly limestone, dark blue, fossiliferous,	10'
11.	*Bastard limestone*,	20'
12.	Limestone, blue,	20'
13.	Bluish-black shelly limestone,	40'
14.	Limestone, more massive, bluish,	6'
15.	Limestone, dark blue or blackish,	14'
16.	Dark blue shelly limestone,	15'
17.	Shaly, dark limestone to base of L. H. L.,	10'
	Total thickness,	205'

The top of the *Lower Helderberg* is nowhere to be seen in this township since it is covered up under the beds of surface débris which border the Susquehanna river.

The Stromatopora bed would belong somewhere in No. 7, but as this was but freshly quarried, and its edge alone exposed, the *corals* are scarcely discernible, and they certainly are not so numerous as in Montour township.

No. 6 is an impure limestone quite dark and lies in flag-like layers 2″–5″ thick, the surfaces of which are covered with *Leperditia alta*. It resembles the *Water-lime* in physical aspect.

Nos. 9 and 10 are somewhat impure, but are burned in the kilns for agricultural purposes.

The upper portion of the "Bastard limestone" is used for building stone since it splits out in rectangular blocks of almost any desired size. The lower 15′ has the buffish-gray aspect peculiar to this stratum, and it contains many minute *Beyrichias* and fragments of other fossils.

The Bossardville limestone is represented by Nos. 12–17 inclusive, having a thickness of 105′. These beds are quite

dark, the most of them thinly laminated, and they furnish the purest lime in the quarry. Much calcite occurs in radiating veins through these beds.

Just east from this opposite the station at Lime Ridge there is another large quarry in the *Lower Helderberg limestone*, operated by Mr. Woolley, and there the exposure reveals the following:

Quarry opposite Lime Ridge Station (*Fig. 76, page 254.*)

1.	Gray, shaly limestone, fossiliferous,	5'
2.	*Stromatopora bed,*	10'
3.	Bluish-gray limestone,	25'
4.	*Bastard limestone,*	20'
5.	*Bossardville limestone,* . . . visible,	40'

No. 1 contains many fossils in a fragmentary condition, and in it were seen *Atrypa recticularis*, *Orthis* sp? *Cladopora multipora* ? and a fragment of *Dalmanites* sp ?

Specimens of *Stromatopora concentrica* ½'–1' in diameter occur in No. 2, and also *Favosites*, *Zaphrentis*, *Rhynchonella formosa*, and *Strophomena rhomboidalis*.

The *Lime Ridge* begins very abruptly just east from this quarry, rising suddenly from the level plain to an elevation of 110' above the terrace deposits on the south, and 60'–75' above the Salina valley on the north, the rocks dipping S. 15° E. 30°–35°.

Westward the *ridge* extends unbroken for nearly a mile; but to the east nothing is seen of it within this township, its eroded rocks being buried deeply by the terrace deposits.

The line of its strike would cross the D. L. & W. R. R. about half way between Lime Ridge and the eastern boundary of this township; since, at the latter point, the *Salina beds* are seen dipping under the north shore of the Susquehanna river; and hence the outcrop of the *Lower Helderberg* should be looked for near the middle of the river.

At the western end of Lime Ridge there is a large quarry operated by Mr. Hess. The *Bossardville beds* only are mined at this locality, 60' of which are exposed, dipping rapidly south, and capped at top by 15' of the *Bastard*

limestone, whose insolubility seems to have been one of the chief agents in preserving this *ridge* standing out above the plain in a dyke-like mass.

The Lower Helderberg limestone sinks from sight just west from Mr. Hess', and nothing remains of the *ridge* except the lower bluff of impure greenish beds of the *Upper Salina* which underlie the *Bossardville limestone.*

A bed of bluish-gray impure limestone occurs about 50′ below the top of the *Salina*, and it makes the bluff which bounds the wide valley on westward from Mr. Hess' quarry several yards north from the *Lower Helderberg ridge.* It has been quarried to a small extent on the land of Mr. J. Pohe, a few rods west from Hess' quarry, where 20′ of impure, buffish, and bluish-gray limestones are visible.

West from this the same bed has been quarried and an attempt made to burn it on the land of W. Miller, but it slacks very badly and the quarry is now abandoned.

Mr. S. Pohe has also tried to burn it, thinking that it was the same ledge as that so conspicuously exposed in Lime Ridge, but those beds are buried under the plain several yards south from the outcrop of this stratum.

Lead and Zinc have been found in small quantity near the western line of this township in the rocks associated with the bed into which Pohe, Miller, and others have quarried for lime; and some New York capitalists have expended several thousand dollars in attempting to develop the ores in paying quantities. A tunnel for this purpose was driven into the bluff for several rods, just west from where the road turns south to Levi Miller's; but nothing of value was discovered in quantity sufficient to warrant mining, although some rich nuggets of *Galena* and *Zinc ore* were found. So far as I could determine, these minerals seem to come in the rocks which belong near the junction of the *Bossardville limestone* with the *Upper Salina* impure limestones, and are therefore at about the same geological horizon as the *Lead and Zinc* mine in Northumberland county, three miles below Sunbury.

The Middle Salina beds come up to the north at an angle

of 30° where the road crosses the little run near Mr. P. Miller's, at the western line of this township.

Bowlders of Pocono conclomerate, angular, and some of them 5′ in diameter, are seen resting on the *Bloomsburg red shale* along the summit of Montour ridge, near F. Hagenbuch's, at an elevation of 750′ A. T.; and with them are many small, rounded, and polished bowlders, together with much finer detrital matter.

The Bloomsburg red shale (Salina Lower) contains quartz veins 1″–3″ in thickness along the road that passes northward up the east branch of the stream which puts into the Susquehanna river at Centerville. *The Middle Salina beds* begin just north from where the road first crosses the stream, and they continue on northward interstratified with pale green or buffish limy shales, dipping S. 15° W. 20°; but at the forks of the road near A. Hutchinson's the *Bloomsburg red shale* comes up, and the soil is all red along the roads, while chunks of cellular quartz 3″–4″ in diameter are scattered over the ground. Angular bowlders of *Pocono conglomerate* and small rounded ones are also found on the surface here.

One of these *Pocono bowlders* 5′ in diameter is seen in a field just east from Mr. E. Hutchinson's at 725′ A. T. No traces of *glacial action* can be seen on the surfaces of the rocks exposed in this township, and yet these large angular bowlders lying about on the highest summits look very much as though they had been transported by such agency.

The Montour axis passes very close to Mr. Hutchinson's; for, in descending the road in West Brier creek, just north from this, the *Salina beds* are seen dipping N. 15° W. 30°, and on going further north to the cross-roads at School-House No. 2, we come to the outcrop of the *Lower Helderberg limestone*, though it is here covered by surface débris.

This limestone shows on the surface a short distance east, and nearly opposite Lamon's store, where it has been quarried and burned on the south bank of Brier creek by Mr. Miller. The beds there exposed in a low ledge dip N. 10° W. 35°–40°, and belong to the base of the *Bossardville group*, for the beds are quite flaggy, and a short distance

west where the creek bends south the pale drab and greenish beds of the *Salina* make their appearance directly under the lowest layers seen at *Miller's quarry.* The beds at the latter quarry are somewhat earthy and do not all slack well, since the purer beds in the upper portion of the *Bossardville series* lie buried under Brier creek, and the rest of the *Lower Helderberg* is concealed by the trash which covers up the valley just north.

The Lower Helderberg limestone crops out in a ledge on the north side of Brier creek about one mile west from Miller's, and has been extensively quarried at the roadside by Mr. Martz near G. H. Ketchner's The rock is very dark blue, almost black, in thin, flaggy, layers through which radiate streaks of calcite. No fossils were seen, and hence this stratum, of which about 30′ are exposed at Martz's quarry, represents a portion of the *Bossardville beds;* dip N. 10°–15° W. 30.

The Hamilton beds come in as we go north from Martz's quarry, and are seen cropping out along the road just north from Connor's tannery, where they have been dug out for use in repairing the roads.

They are there dark-olive shales and dip N. 10° W. 45°, while they cleave at the same angle to the south. These beds belong to the *Hamilton* proper; but as we go north the rest of the *Hamilton series* descends, covered up by débris, and 150 rods north from the Tannery the basal beds of the *Chemung* come down, making a prominent ridge which rises 200′–300′ above the *Hamilton valley.*

The rocks dip northward at the rate of 50°–60° for several hundred feet above the base of the Chemung.

The top of these latter beds comes not far north of the forks of the road near Allen Shellhammer's; since, when we come to the cross-roads at C. Boone's, 90 rods north from the latter locality the red beds in the *transition VIII–IX series* are seen along the road, but very poorly, vast quantities of transported bowlders and finer trash cover up the rocks in that vicinity.

In passing westward from the cross-roads at C. Boone's the road takes a course somewhat north of west, and con-

sequently gets upon the *Catskill beds*, which skirt the southern foot of Huntington mountain, as a broad plateau at 900′–1000′ A. T., and then make the steep slope of the mountain to its summit at 500′–600′ higher, where they are crowned by the basal beds of the *Pocono* at the extreme northern line of the township.

Since no streams cut through these beds (X and IX) they are not exposed in detail within this township.

The Catskill beds underlie the surface at Mr. J. S. Remley's; for when the bowlder deposits are dug through in wells red shales are found.

High bowlder deposits. These bowlders occur here at 1000′ A. T., and the huge piles of them seen just east from Mr. Remley's near the new church certainly recall the appearance of glacial moraine. Since the Ice is known to have come as far west as the next township to the east it looks as if a lobe of it passed along the base of Huntington mountain and transported the great heaps of rounded and angular bowlders which are scattered over the Catskill plateau in this township.

In passing south from Remley's everything is covered up with these bowlder deposits until we come to Mrs. Whitmire's; just south from which the Chemung beds crop out dipping N. 10° W. 40°. These must be very close to the top of the *Chemung*, however, since about 50 rods south from this the *Stony Brook* olive-green beds (filled with *Productella*, *Leiorhynchus* and *Spirifera*) occur on the roadside dipping northward at the rate of 55°.

The Chemung beds end about 50 rods north from the forks of the road near Geo. Conner's, for here the ridge breaks down and the peculiar topography of the *Hamilton* begins; and when we come to Mr. Conner's, dark, slaty beds occur along the road, in which was seen *Nautilus marcellensis;* hence they are probably the *Marcellus slates.*

These same dark, slaty shales occur all along the road eastward to J. F. Conner's; but when we pass southward here toward West Brier creek they disappear under the old buried valley, and no more rock outcrops occur until the south bank of Brier creeek is reached, 90 rods away,

when the pale green shales and impure limestones of the *Upper Salina* come up; so that the *Lower Helderberg limestone* would set in just north from Brier creek opposite J. F. Conner's.

In ascending the hill south from Brier creek the rocks are all pale green, limy shales, and magnesian limestones until we come to 50 paces south from the forks of the road, or 110 rods from the creek. Here *red beds*, interstratified with buffish and pale-green shales and limestones begin to come up, and about 200 yards further south the soil is all red, and we reach the *Bloomsburg red shale* on the crest of the *axis*.

The Upper Salina beds are frequently seen cropping out along the roads which run east and west from the Union church near School-House No. 5.

The *Helderberg* must have its line of strike nearly in the bed of West Brier creek, which here flows in a wide buried valley, completely concealing the limestone from sight. But there are possibly some localities along this line where it could be uncovered by removing a small thickness of the superficial deposits, but they would be difficult to find, and it is more than probable that it has been removed by erosion and solution to a considerable depth below the present surface.

The Marcellus beds have been dug into near Fowlerville, at the western line of this township, by some one exploring for *roofing slates;* but as they do not cleave there, but only split into thin layers along the lamination planes they could not be used successfully for roofing material.

The Salina beds are well exposed for several rods along the little stream which puts into the Susquehanna east from Willow Grove, near the eastern line of the township. Near the head of this stream, one half mile north from the Susquehanna river, the shales are all *red* (*Bloomsburg*) and dipping gently south; but as we approach the D. L. & W. R. R. buffish and pale green limy beds come in and continue interstratified with the red (*Middle Salina*) until we come to the canal, where the *red* beds have all disappeared and the pale green shales and limestones of the *Upper Sa-*

lina dip at the rate of 30° S. 10° E. into the Susquehanna river; and this dip continued would bring the *Lower Helderberg limestone* into the middle of the stream at this locality.

Just above the Ferry at Lime Ridge, and opposite Stonytown, the *Hamilton beds* are seen extending nearly across the channel of the Susquehanna river.

Barometric elevations in Centre.

	A. T.
Susquehanna river at Willow Grove,	468'
Forks of road near M. W. Jackson's,	650'
" " 88 rods next south,	650'
" " at Hagenbuch & Co.'s house,	515'
Level of creek at crossing next north,	525'
Level of creek at crossing next north,	570'
Forks of road at Cider Mill,	625'
" " next west from S. Hutchinson's,	725'
West Brier creek at crossing near H. Shaffer's,	555'
Cross-road at School-house No. 2,	575'
Forks of road at A. Boyd's,	585'
Level of stream here,	580'
Cross-roads next west,	625'
Forks of road at J. P. Conner's,	635'
" " at D. Harman's,	775'
Creek here,	755'
Forks of road next north,	925'
Cross-roads at C. Boone's,	880'
Forks of road at J. S. Remley's,	960
" " at Charles Whitmire's,	915'
" " at R. Sitler's,	870'
" " near Phebe Whitmire's,	905'
" " 85 rods next south,	800'
" " near Geo. Conner's,	675'
" " " Mrs. E. Hess's,	665'
West Brier creek next south,	610'
Forks of road west of Elias Creasy's,	670'
" " 86 rods east of last,	630'
Cross-roads near W. Shaffer's,	690'
Forks of road north of I. Hess's,	600'
Crossing of run near P. Miller's,	575'
Next crossing above,	615'
" " "	655'
" " "	700'
Forks of road at F. Hagenbuch's,	750'
" " near J. Hagenbuch's,	700'
Cross-roads at Union church,	685'
Forks of road 238 rods east,	660'
West Brier creek next north,	615'

Forks of road near Samuel Hagenbuch's,	675'
" " " Jno. Sitler's estate,	845'
" " " Levi Fester's,	815'
" " " Abram Culp's,	900'
Elbow in road at L. Erwine's,	925'
Susquehanna river opposite Lime Ridge,	465'

53. *Brier creek township.*

This township lies next east from Centre, along the north bank of the Susquehanna river to Luzerne county.

It is drained entirely by Brier creek, except the extreme northern portion which drains eastward via West Shickshinny creek to the Susquehanna river at Shickshinny.

Huntington or Fishing Creek mountain runs along the extreme northern boundary of the township, in fact its crest is the line, and the northern rim of the Wyoming basin is made by the hard rocks of the *Pocono formation No. X.*

Knob mountain is the south rim of the Wyoming basin along which the other *Pocono* outcrop runs.

At the eastern line of this township these two crests are separated by nearly a mile and a half.. A deep valley occupies the intervening space. Westward these mountains gradually approach each other and unite at the west line of the township.

The Montour axis passes under the town of Berwick in *Salina beds.* In Luzerne county just east from this the lowest beds exposed are the *Marcellus.*

The highest rocks found in this township belong to the *Mauch Chunk shale,* since it occupies the spoon-shaped valley between the Knob and Huntington mountains in which Shickshinny creek now flows.

The Mauch Chunk beds have, however, completely disappeared through erosion from the slopes on either side of the valley, and as the valley itself is deeply buried by a great depth of Drift trash it is possible that the *Mauch Chunk beds* have been nearly all removed from this trough and that the Pocono conglomerates form the floor of the drift-covered valley as it does the bounding slopes.

Pocono coal. Mistaking the *Griswold's Gap conglomerate* of the *Pocono* for the *Pottsville conglomerate*, they explored the summit of the Knob-Huntington mountain for *coal* at the north-western corner of this township. A diamond drill hole was put down about 200′ and some thin *coaly streaks* were found in the *Pocono rocks.*

The Pocono is tolerably well exposed along the roads which lead across the mountains and seems to consist largely of very coarse, gray conglomerates dipping S. 10° E. 40° in Huntington mountain and N. 10° W. 35° in Knob mountain.

The crest of the northern mountain has an almost uniform height of 1500′ A. T., and there are no gaps in it. The crest of the southern mountain is nearly the same height, but in two places is cut down 225′–270′ below this general elevation by two gaps about one mile and a half apart, and the western one occurs just east from where the valley between the two mountains points up.

These two gaps seem to have been cut by waters that flowed from the Terminal Moraine of a prong of the great glacier which stretched westward along this canoe-shaped valley; for, there was no exit westward, as the valley spoons up to the top of the mountain in that direction only one mile west from the deeper gap. Hence these low places seem to have served as waste wiers through which the melting waters from the *Ice sheet* that filled the valley escaped southward into the Susquehanna valley, and cut down the rim nearly 300′. The western gap has an elevation of 1230′ and the eastern one 1275′ A. T.

The terminus of the glacier which filled the valley between these mountains was somewhere between the two roads which cross the mountains in this township; for, at the eastern road the valley is piled full of rounded and angular bowlders which make great heaps eastward through Luzerne county to Shickshinny; whereas at the western road only a few of these bowlders are found, and these were doubtless transported by the water flowing from the glacier.

The Catskill beds occupy a belt about one mile and a

quarter wide across this township, the uppermost rocks making the steep south slope of the Knob mountain; and the lower two thirds spreading out in a wide plain, covered with Drift to such a depth that their outcrop is almost completely concealed; at least this is true for all except the extreme western portion of the township, where the base of these beds is seen for a few feet near the cross-roads at A. Kisner's. The dip is there N. 15° W. 45°–50°, and the same dip if continued to the outcrop of the *Pocono* at the north, would give a thickness of about 4500′ for the *Catskill beds.*

The transition VIII–IX series begins (at S. Kisner's) with some olive shales in which some fossils occur, a form much resembling *Spirifera disjuncta* being especially abundant. On below this, as we descend the branch of Brier creek from S. Kisner's, alternate beds of olive shales, greenish sandstones and *purplish red shales* occur for 800′ to 1000′, when the genuine *Chemung* comes in and the *red beds* are seen no more.

The Chemung beds continue along this stream as we descend it dipping 50°–55° N. 15° W. until within 45 rods of the cross-roads at C. Bachman's when the *Hamilton* sets in; and the *Chemung ridge* sinks suddenly to a wide plain 200′–300′ lower than the *ridge.*

The Chemung and *Chemung-Catskill series* together occupy a belt about 300 rods wide, and as the dip is never less than 45°, and frequently 50°–55°, the combined thickness of the two series is about 3500′, which agrees quite closely with the measurements made in other portions of the district.

The contact of the *Chemung* with the *Genesee* is seen about 25 rods north from Evansville P. O.

Just north from this a sandy bed of the *Chemung* makes a cascade in the stream.

The base of the Chemung is seen on Martz's branch of Brier creek just above Mr. J. W. Houk's, the dip being N. 15° W. 40°.

The junction of the *Chemung* and *Genesee* is also seen just north from Foundryville, at the forks of the road near

Mr. A. Fowler's. In all these cases the surface rapidly slopes up into a ridge 200′–300′ above the *Hamilton valley;* so that the presence of the *Chemung beds* is indicated by the topography.

The Hamilton formation covers a belt about 150 rods broad along the foot of the *Chemung ridge*, and as the dip is about 35°–40° would have a thickness of near 1200′.

The Tully limestone is concealed at every place examined in this township, though it is doubtless present at its proper horizon.

The Hamilton proper and a portion of the *Genesee* are quite well exposed along the roads in the vicinity of Foundryville.

The Genesee is a bluish-black slate, somewhat sandy in the upper portion and totally non-fossiliferous.

Dark fissile shales are seen cropping out along the road near the Luth. Ch. in Martz's school-district, and they probably belong to the *Marcellus*, since the *Lower Helderburg limestone* comes up only 40 rods south.

West from this last locality where the by-road turns off to F. T. Adams', dark shales occur at the roadside cleaving S. 15° W. 50° or almost exactly at right angles to the dip.

The Hamilton beds are also quite well exposed along Brier creek at the western line of the township between C. Bachman's and S. Kelchner's, where at the latter place dark fissile beds seem to represent the *Marcellus* ; and, as we go north the *Hamilton proper*, lighter in cast and more sandy, comes in.

The junction of the *Marcellus* with the *Lower Helderberg* is everywhere concealed in this township, through at S. Kelchner's, the lowest exposed beds cannot be more than 50′ above the *Lower Helderberg limestone.*

The Oriskany is most probably entirely absent, since there is not a single trace of its bowlders to be found.

The Lower Helderberg limestone has long been quarried and burned about one mile north-west from Berwick on the lands of Messrs. Petty, Martz, and Evans. These are the

most eastern localities at which the limestone occurs in the district, since it here passes under the great bowlder deposits which cover the wide plain around Berwick; and when the rocks come to view along the crest of the *Berwick* (*Montour*) *axis* in Luzerne county the *limestone* is buried below drainage by the overlying *Hamilton beds.*

Mr. M. H. Petty has the *quarry* furthest east. It is just east from Brier creek and nearly north from the western boundary of Berwick borough. The rock is of a light gray color, somewhat slaty and impure, and it probably belongs near the base of the *Lower Helderberg.* It does not slack very freely and the quarry is not now in operation. The beds dip N. 10°–15° W. at 35°, and only 25′ of limestone are exposed here.

A short distance west from Petty's there is another *quarry* on the land of Mr. Martz, where we see hard, dark-blue limestone overlain by 6′ of bluish, slaty beds, above which come bluish-gray limestones. This quarry has been operated for a long time and the best of the stone has been taken out. The rocks exposed here have a thickness of 40′ and seem to belong in the *Bossardville series.*

A short distance west from Mr. Martz's quarry the *Lower Helderberg limestone* is again *quarried* and burned quite extensively on the land of Mr. Frank Evans, where we see 30′ of dark blue and almost black, flaggy limestone beds through which run many seams of calcite, and as the rock is apparently non-fossiliferous there can be no doubt that it is a portion of the *Bossardville limestone.*

Just west from this also on the land of Mr. Evans, another *quarry* was once opened in higher limestones of a gray color, and *fossiliferous.* The rock is somewhat rough and sandy, however, and, not slacking well, the quarry has been abandoned.

Strophomena rugosa, *Atrypa recticularis*, *Stromatopora concentrica*, and other forms were seen at this locality.

The Lower Helderberg limestone crosses Brier creek at the western line of this township, just west from the M. E. Church near School-House No. 8, and was once *quarried* there on the land of Mr. J. W. Eck. The limestone is quite

impure, however, and does not slack well. It seems to belong in the lower portion of the *Bossardville beds*, if one may judge from its slaty structure and non fossiliferous character.

The Middle Salina, (red shales alternating with buffish limy beds,) is seen rising rapidly southward along the road at the forks near J. W. Eck's. South from this point the dip N. 15°–20° W. 40° soon brings up the *Bloomsburg red shale* along the *anticlinal*, which passes through the cemetery grounds of the Union church in the southern edge of School-District No. 8, for here the dip is reversed and the rocks pitch southward, gently (5°–10°) at first, but with increasing steepness as we go further south until at the river the uppermost beds of the *Salina* pitch below its northern shore at the rate of 35°.

This is at the western line of the township, but eastward the river shifts to the south, and the outcrop of the *Lower Helderberg* leaves the bed of the Susquehanna, and passing north of the same, under the great piles of transported bowlders which cover the banks of the Susquehanna, is seen no more toward the east.

The Marcellus and Hamilton beds are seen in the bed of the river at Berwick, dipping rapidly southward; and the water flowing along the strike of beds (varying so much in hardness) has eroded them quite unequally, so that they make a series of rapids in the river, which falls more than 5′ in a few rods. At one point near the northern shore a long narrow trough has been cut out of the softer beds, and the water descending into it with a fall of 2′–3′ from every side gives quite a wild appearance to the channel of the stream at this locality.

The rocks do not extend to the north shore of the river, and the current was so turbulent that I could not approach them in a boat near enough to determine their character certainly, when I was in the vicinity of Berwick; so that some doubt remains as to whether the lowest (most northern) beds seen in the channel of the Susquehanna at Berwick are shales or impure shaly limestones. Viewed from

a distance some of the beds look like the impure limestone found in the *Stormville shales*. If so, the *Lower Helderberg beds* line the northern side of the Susquehanna river at Berwick.

As confirmatory of this last supposition may be cited the fact that an enormous spring of cold water wells up from the bed of the river near its northern shore indicating the existence of limestone rocks beneath. This spring supplies Berwick with water, being pumped up by the waste water flowing from the canal lock at this point.

The town of Berwick is built on a wide terrace of bowlders and other trash which rises precipitously from the river to an elevation of 100′ above the same, and then spreads northward and westward for more than a mile at nearly the same height (575′ A. T.)

Mr. H. Carville Lewis, who has made Glacial phenomena the subject of special study in this and other States, recognizes in this vast deposit of rounded and angular bowlders of every description, sand, gravel, and other trash, the *Terminal Moraine* of the great *Ice sheet*, which descended the Susquehanna valley to Berwick. From this point he has traced it northward across Knob and Huntington mountains into New York.

It is possible, however, that Brier creek, (which now flows along the northern edge of this deposit and enters the Susquehanna two miles below Berwick,) may have played a part in its origin; for as we pass westward from Berwick the height of the deposit gradually declines until we come to Brier creek, west from which none of these upper bowlder beds occur. This suggests the thought that the deposit may have been built up at the confluence of Brier creek and the Susquehanna during the *Flooded river epoch* by rehandled glacial débris shed from the higher slopes along both streams; since a bowlder bed comparable to this one is found at the junction of every large stream with the Susquehanna within the district, whenever the debouching streams drain a glaciated region.

What renders the origin here suggested for these deposits more probable, is the fact that Brier creek would have received all the waste water and trash which poured out of

the inclosed West Shickshinny valley at the north line of this township, through the two old gaps which remain as monuments of the erosion produced by such southward flow.

Since this seems unquestionably to have taken place, a vast volume of water (for there was no other outlet for the water from the melting ice in West Shickshinny valley) must have rushed down Brier creek carrying a load of trash and bowlders until checked by the more slowly moving Susquehanna. The coarser material would have been deposited where we now find it; for, as we go eastward beyond where Brier creek debouched into the Susquehanna during the *Flooded river epoch* the deposit gradually disappears.

I could find no *glacial scratches* on any of the rocks in this township. But very large (3′–5′ in diameter) bowlders of *Pocono* and *Pottsville conglomerate* are spread over much of the *Catskill area* along the base of Knob mountain; and although they may have been transported by floating ice, it seems more probable that they were dumped down where we now find them from the face of the *glacier*.

Barometric elevations in Brier creek.

	A. T.
Susquehanna river at Berwick,	475′
General elevation of Berwick terrace,	575′
Forks of road near S. Smith's, just north of Berwick,	590′
Forks of road next north of last,	595′
Level of Brier creek at crossing next east,	600′
Forks of road in Foundryville,	645′
" " " near A. Fowler's,	685′
" " " " J. Miller's,	965′
Cross-roads at M. E. Church,	1025′
Summit of ridge just north of last,	1050′
Brier creek near G. Miller's,	900′
Cross-roads at School-House, just north,	935′
Summit of gap next north in Knob mountain,	1230′
Level of Shickshinny creek at crossing next north,	1140′
Summit of Huntington mt. on road next north,	1500′
Forks of road near P. Linden's,	990′
Cross-roads near A. Sults',	1225′
Summit of gap in Knob mt. just north,	1275′
W. Shickshinny creek at crossing north from Jno. Seybert's,	1080′
Level of spring at roadside next north,	1235′
Summit of Huntington mountain on this road,	1500′
Forks of road near S. Sitler's,	830′

Cross-roads at School-House No. 6,	920'
" near S. Knorr's,	835'
" " S. Kisner's,	770'
Crossing of creek next south,	695'
" " "	660'
Cross-roads at C. Bachman's,	645'
Forks of road near S. Kelchner's,	590'
Brier creek here,	560'
Forks of road at M. E. Church just east,	580'
Brier creek near J. W. Eck's,	550'
Forks of road near W. Evans',	620'
" " " at Evansville P. O.,	635'
Level of run here,	630'
Forks of road north from W. Hippenstell's,	735'
Summit between last and School-House No. 6,	950'

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54. *Mifflin township.*

This area is a long, narrow strip lying along the south bank of the Susquehanna river opposite Brier creek and Center township; its south boundary running along the crest of the Nescopec mountain rudely parallel to the Susquehanna river and 2½–3 miles distant.

No large streams empty into the Susquehanna river from this township; it is drained entirely by brooks which rise on the slope of the Nescopec mountain and flow with rapid descent northward to the river.

The rocks of the township extend from the *Pocono beds* in the summit of Nescopec, down to the *Lower Helderberg limestone* in the bed of the Susquehanna opposite Mifflinville.

The dip is everywhere S. 10° W. 40°–45°.

The Pocono beds make the long, straight crest of the Nescopec mountain which rises steeply, from the plain of *Catskill rocks* along its northern foot, to an elevation of 1500'—1550' A. T. Over the *Berwick* (*Montour*) *axis* the place of the *Pocono* would be more than 7000' above the present surface.

The red beds of the *Catskill* extend to within a few feet of the crest, so that only a thin comb of *Pocono* comes into this township.

The Catskill and *Chemung-Catskill strata* cover a belt

nearly one mile and three quarters wide, an undulating plain extending south from the *Chemung ridge* to the foot of the Nescopec mountain.

On Ten Mile run the base of the *transition VIII–IX beds* comes near D. Watter's; and the base of the *Catskill* proper sets in nearly opposite Mr. J. Aten's.

The Catskill beds contain much *red shale*, if one may judge from the topography and from red soil along the roads and in the fields. The exposure of these rocks are quite poor within this township, since no streams except small ones cut across them, and they are in many places covered up with surface débris.

The Chemung rocks rise in a steep low ridge a few rods south from the Susquehanna river, dipping S. 15° E., and cover a zone about two thirds of a mile broad.

The Stony Brook beds, filled with their characteristic fossils, are seen on Ten Mile run just south from D. Water's; and in passing northward the rest of the *Chemung* under them is quite well exposed, dipping quite uniformly S. 15° E. 45, though occasionally the dip falls off to 40°. The exact distance across these beds below the *Stony Brook horizon* is about 175 rods at this locality, thus giving a thickness of somewhere between 1900′–2000′, since the dip is never less than 40° nor greater than 45°. This result agrees quite closely with that obtained for the thickness of these beds in other portions of the district.

The Stony Brook beds are also quite well exposed along the road between Hetlerville and Mifflinville where it passes from the Smith school-district into Snyder near Mrs. Lutz's house. They are olive-green and shaly, filled with vast quantities of *Spirifera disjuncta*, *Productella hirsuta*, *Leiorhynchus mesocostale;* and all dip southward at the rate of 45°.

The Genesee shales are seen cropping out along Ten-Mile run between the forks of the road at Brown's Mill and the one next south; they are dark-blue and blackish sandy slates in which no fossils were observed.

The Tully limestone occurs at the cross-roads near Brown's Mill in impure ashen-gray layers, often showing a

tinge of buff on the weathered surface, and a dark-blue cast on the interior of freshly-broken pieces.

The *Hamilton* proper and the *Marcellus* underlie the south bank and bed of the Susquehanna, the whole length of the township; except where the river bends northward opposite Mifflinville where for nearly a mile the *Salina beds* come into the channel of the stream near its northern shore, and the *Lower Helderberg limestones* come out to the middle of the river.

The Hamilton and Marcellus rocks are seen projecting from the bed of the Susquehanna for more than two thirds of the distance across its channel just above the Stonytown ferry, one mile below Mifflinville.

No transported bowlders were observed on the highlands of this township.

I saw no evidence that the *glacier* ever covered any portion of it.

Along the river transported bowlders are abundant in terrace deposits. Near Mifflinville two very broad terraces occur. The top of the upper comes at 75′ above the Susquehanna river, and its riverward slope descends almost vertically to the top of the lower one at 50′ above river level, or 515′ A. T. Both terraces are covered with small rounded bowlders and other transported material.

Barometric elevations in Mifflin.

	A. T.
Susquehanna river at eastern end of township,	475′
" " at Mifflinville ferry,	468′
" " at Stonytown ferry,	465′
General level of Mifflinville terrace,	515′
Forks of road near Brown's Mill,	550′
Crossing of Ten-Mile run 75 rods south,	560′
Forks of road near Mrs. Yohe's,	630′
Crossing of run next south,	645′
Forks of road at Schweppenheiser's school-house,	660′
Ten-Mile run at crossing next east,	600′
Forks of road near A. Schweppenheiser's,	645′
Ten-Mile run next east,	685′
Summit of Nescopec mountain on road running south from last,	1520′
Crest of Nescopec just east or west from last,	1625′
Summit of Nescopec mountain on road leading south-east from Hettlerville,	1550′

Forks of road near H. Kelchner's,	925′
" " just south from Lutheran church near Mrs. Lutz's,	830′
Level of stream at crossing just east of last,	815′
Forks of road in Hettlerville,	900′
" " at G. Swank's,	845′
" " next west,	850′

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55. Maine township.

This lies west from Mifflin along the south bank of the river.

Catawissa creek, flowing north-west through the southern half of the township, drains its entire area westward.

The section of the rocks extends from the *Mauch Chunk shale* at the southern line of the township down to the *Hamilton* found along the banks and bed of the Susquehanna river; the dip being continuously southward at the rate of 35°–45°.

Nescopec mountain, formed by the upturned hard conglomerates of the *Pocono*, extends across the southern part.

Catawissa creek cuts squarely through it, in a deep, narrow gorge, on either side of which the *Pocono* and underlying *Catskill-Pocono* beds are fairly well exposed. In passing through this gorge along the eastern bank of Catawissa creek the following section was constructed:

Section in gap of Catawissa creek through Nescopec mountain and southward (Fig. 77, page 254.)

1. *Mauch Chunk shale*, (visible,)	50′	
2. Sandstone, yellowish-gray, coarse, massive top of *Pocono*,	30′	X.
3. Concealed,	250′	X.
4. Massive, gray, coarse conglomerates in several beds, dipping S. 15° E. 40°,	300′	X.
5. Mostly concealed, with some outcrops of sandstones making cliffs, and massive, gray beds at base, dip 40°,	300′	X-IX.
6. Sandstones, gray above, but passing down into reddish ones below,	75′	X-IX.
7. *Red shale* top of *Catskill*, dip 40°,	100′	
8. Sandstone, greenish-gray, typical Catskill,	15′	
9. *Red shale*, with a few thin bands of greenish sandstones, dip S. 15° E. 40°,	100′	

10.	Sandstone, greenish-gray, and yellowish somewhat shaly,	80′
11.	*Red shale,*	85′
12.	Concealed to the bridge across Catawissa creek in Mainville and on a line with the northern foot of Nescopec mountain,	100′
13.	Red shales, green sandstones, and concealed to forks of road near Rudolph Shuman's, dip 40°,	2000′
14.	Red shales alternating with greenish-gray beds and concealed,	1100′
15.	Greenish-gray beds, (dip 40°–45°,)	300′
16.	*Red shales,* and concealed,	25′
17.	Concealed with some red beds visible,	275′
18.	Reddish, shaly sandstone,	10′
19.	Red, olive, and gray shales and concealed, *much red shale,*	300′
20.	*Red shale,*	10′
21.	Olive, gray and green sandy shales,	125′
22.	*Red shale,*	10′
23.	Olive shales to cross-roads at German Luth. Church,	110′
	Total height of section,	5650′

Pocono beds (X) Nos. 2–4 inclusive,	580′
Transition X–IX Nos. 5 and 6,	375′
Catskill (IX) Nos. 7–20 inclusive,	4400′
Transition IX–VIII (Nos. 21–23),	245′

No. 4. *The lowest Pocono rock* of this section makes the summit of the mountain. It contains several conglomerate beds 20′–30′ feet thick, all of which are quite coarse, some of the pebbles being 2″–3″ in diameter. The rock is mostly grayish-white, with sometimes a faint tinge of reddish yellow.

The Griswold's Gap conglomerate belongs somewhere in this mass, and it is possible that the whole 300′ is only the expansion of that pebbly bed of Wayne county.

The transition IX–X series is here only 375′ thick, for the genuine *Catskill rocks* begin (descending) with No. 7 of the section, which would represent the top of the *Mount Pleasant red shale*, of Wayne and Susquehanna counties.

The base of the *Catskill* was arbitrarily fixed where the *olive beds* make their appearance (descending) and the *red shales* become comparatively rare; these latter rocks being considered *transition VIII–IX*. That this division line cannot be very far from correct is shown by the fact that

the resultant thickness of the *Catskill beds* comes out very closely to that obained in other portions of the district.

The exposures throughout the main portion of the *Catskill* are not good; so that the detailed structure could not be made out for much of its thickness; but it would appear from the topography that *red shale* forms much the larger portion of the series.

The base of the *Chemung-Catskill beds* is not exposed; but on projecting the strike of these rocks at this horizon from the adjoining township, both east and west, it is found to pass about 100 rods north of the cross-roads at the German Reformed Church.

At the forks of the road just west from P. Hartzell's, one mile west from the Luth. Church the *red beds* begin and dip south 15° E. 40° for 110 rods to the forks of the road near Catawissa creek. Here a very massive greenish-gray sandstone comes down and its top forms a broad, bare sheet of several square rods in extent along the creek road where it has been *quarried for building stone.*

Just under this sandstone is an olive shale 40′–50′ thick which contains many fossil shells which much resemble *Spirifera disjuncta.* Directly on top of it begins a thick, red shale, 100′ of which is seen, and the broad valley of Catawissa creek is here excavated from it.

In the base of this *red shale* the *fucoid-like plant* figured in Geology of Pennsylvania, 1858, Vol. II, Plate XXIII, appears in great quantity, and seems to come at the same geological horizon as the specimens obtained in the Susquehanna gap above Pittston, from which the first was figured

The Chemung rocks extend from the base of the *Catskill-Chemung beds* northward to the south shore of the Susquehanna river where they end abruptly in a steep ridge which overlooks the river all along the northern border of the township, the beds dipping 40°–45° S. 10°–15° W. throughout the entire thickness.

The Genesee shale forms the steep slope of this *Chemung ridge.*

The *Tully limestone* occurs in the bank of the river.

The *Hamilton* proper extends across the channel.

All three formations dip rapidly (35°–45°) southward.

The Tully limestone lines the bluff of the river along the most of its course in this township, and the rock-cuts along the recently constructed North Branch R. R. are mostly through this stratum, which seems to be about 50′ thick, but is quite impure.

Barometric elevations in Maine.

	A. T.
Catawissa creek under the R. R. bridge above Mainville station,	550′
Forks of road near Rudolph Shuman's,	600′
Cross-roads at Ger. Ref. Church,	800′
Forks of road at Reuben Shuman's,	575′

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56. Catawissa township.

This township lies next west from Maine, along the river. Catawissa creek flows through its central portion westward to the Susquehanna at the western line.

The rocks of this area extend from the *Pocono* down to the *Hamilton* in the bed of the Susquehanna.

The Pocono rocks are found in the summit of what is known as *Catawissa mountain* (though it is only the extension of the *Nescopec mountain* from the Catawissa gap, westward, to its end just east from the town of Catawissa.

Catawissa mountain is not merely the double knob which overlooks Catawissa from the east, and from which so fair a prospect of all Columbia, Montour, Northumberland, Snyder and Union counties can be obtained; but the name properly belongs to all that zigzag range of high land which extends from the *Catawissa knobs* (south-eastward) along the county line, into Schuylkill county, and curving there south and west, unites with and is continued as *Little mountain*, which runs on past Shamokin and Trevorton to the Susquehanna river below Selinsgrove.

The *Catawissa knob* forms the junction of this *Catawissa mountain* with *Nescopec mountain.* As the Huntington knob in Orange township is produced by the union of the

converging (*Pocono*) crests of Huntington and Lee's mountains at the west end of the Wyoming basin, so the *Pocono* mountain outcrops which inclose the McCauley, Black Creek and Hazelton coal basins, on the north and on the south-west, unite to produce the Catawissa knob.

The difference in the two cases is, that the Huntington knob is *single* and the Catawissa knob *double;* and this is owing to the fact that the Huntington knob *basin* is single and its sides compressed together; while the Catawissa knob contains *two basins*, separated by an *anticlinal arch*, all the dips being moderate.

Hence the Huntington mountain is long, straight, sharp, and abruptly terminated; the Catawissa mountain short, round, and double.

By going behind the Catawissa mountain into the Catawissa valley the two basins of red shale can be seen spooning up (westward) toward the two knobs; and a long spur, separating the two spoons, descending to the railroad a mile above Mainville, where the structure can be studied.

The Catawissa knobs mark in fact two projecting zigzags in the *Pocono* outcrop,—the northernmost two of a whole series of such zigzags along the Catawissa mountain into Schuylkill county. For every zigzag there is a short spur and knob, behind which (eastward) lies a basin corresponding to one of the Lehigh anthracite basins.

Each of the knobs or spurs of the Catawissa mountain looking down west upon the Roaring creek country corresponds to a spur of the Pottsville conglomerate plateau looking down west into the Catawissa red shale valley; as will be described in the Anthracite reports.

The Susquehanna river flows along the strike of the *Hamilton rocks* from the eastern line of this county westward to near the middle of the northern line of Catawissa, where it veers southward gradually, and soon begins cutting into the *Chemung beds*, which pass obliquely under, as it veers more and more southward, until, meeting Fishing creek at the western line of the township, the river turns abruptly almost due south, cutting squarely across the remaining

Chemung rocks, and through the *Chemung-Catskill* up into a considerable portion of the *Catskill* before it turns westward at Catawissa.

The North Branch R. R. recently constructed along the south bank of the Susquehanna river has a continuous rock cut from the base of the *Tully limestone* opposite Bloomsburg ferry to the top of the *Chemung* just below where it crosses the Philadelphia and Reading R. R. Exposures in cuts of the latter road are quite good from here south nearly to Catawissa.

Section along Susquehanna river between Catawissa and Bloomsburg ferry, (Fig. 78, page 282.)

1.	*Red shales*, dip S. 10° E. 30°–35°,	50′
2.	Sandstone, greenish, massive, . . . visible	10′
3.	Concealed,	110′
4.	Greenish-gray sandstones, some shaly, and also some reddish-brown sandstones,	200′
5.	Sandstone, gray, massive,	10′
6.	*Red shale*, sandy,	100′
7.	Sandstone, green, flaggy,	40′
8.	*Shales, red*, sandy,	30′
9.	Sandstone, green,	10′
10.	*Red shales*, sandy,	60′
11.	Green sandstone,	15′
12.	*Red shales*,	55′
13.	Green sandstone.	10′
14.	Concealed and *red shales*,	100′
15.	Sandstone, green, current-bedded,	10′
16.	*Red shales*,	90′
17.	Sandstone, greenish-gray, massive,	25′
18.	Concealed, with *red* and green beds occasionally seen,	120′
19.	Sandstone, massive, grayish-green,	15′
20.	*Red shales*,	175′
21.	Sandstone, massive, greenish-gray,	50′
22.	Concealed,	70′
23.	*Brecciated limestone* with *fish* remains,	5′
24.	Olive shales, sandy at top,	40′
25.	*Red shale*,	12′
26.	Concealed mostly, dip 35°–40° S. 10° E.,	550′
27.	Olive shales,	175′
28.	Concealed,	275′
29.	Olive shales,	90′
30.	*Red shales*, sandy, near east end of Rupert bridge of Reading R. R., this being the *lowest red bed* and base of *transition IX-VIII*,	10′
31.	Concealed, (Top of *Chemung, VIII*,)	25′
32.	Soft, olive-green, sandy shales,	100′

33. Concealed, ... 80′
34. Sandstone, flaggy, ... 5′
35. Sandstone, somewhat massive, greenish-gray, ... 15′
36. Olive-green shales, soft, easily weathering, ... 100′
37. Somewhat sandy, olive-green shales, fossiliferous, . . . 50′
38. Olive-green beds with many large *Spirifers* and other fossils, . . . 60′
39. *Stony Brook beds*, bluish-green, and olive-green sandy shales, very fossiliferous and especially rich in *Productella hirsuta*, *Spirifera disjuncta*, and *Leiorhynchus mesocostale*, ... 50′
40. *Spirifer bed*, ... ½′
41. Olive, gray, and greenish sandy beds, with few fossils, and weathering into rough and ragged cliffs, 200′
42. *Spirifer bed*, the prevailing form resembling *S. disjuncta*, ½′
43. Greenish-brown shales, ... 20′
44. Somewhat shaly, very hard, sandy, dark-olive beds, no fossils seen, ... 60′
45. Quite sandy, dark grayish olive beds which make immense cliffs along the hills and extend in long, low, projecting ledges far out into the river's bed, some *crinoidal stems* near base, . . . 100′
46. Hard, olive sandy beds containing *Stictopora sp?* from base to middle, and large *Spirifers* at top, with *Crinoidal fragments* throughout, ... 50′
47. Hard, sandy beds, dark-gray with *Stictopora* and *Crinoidal stems* at intervals of 4′–5′ throughout, ... 65′
48. *Stictopora bed*, ... ½′
49. Hard, olive, sandy beds, ... 15′
50. Olive, sandy beds with several thin layers filled with *Crinoids* and *Stictopora*, ... 45′
51. Layer filled with *Crinoidal fragments*, ... ½′
52. Olive, sandy beds, ... 15′
53. *Stictopora bed*, ... ½′
54. Hard, olive, sandy beds, ... 25′
55. Layer filled with *Stictopora* and *Spirifera disjuncta*, . . ½′
56. Massive, sandy, dark olive-gray beds, ... 130′
57. *Spirifer bed*, ... 1′
58. Very hard, dark-green, and bluish olive beds, no fossils seen, ... 125′
59. *Spirifer bed* filled with *Spirifera mesostrialis*, *S. mesocostalis*, *Orthis impressa*, *Strophodonta cayuta*, *S. perplana*, *Grammysia elliptica*, *Bellerophon expansus*, *Aviculopecten pectiniformis*, and many other forms, ... 1′
60. Bluish-gray, sandy beds, ... 20′
61. *Spirifer bed*, ... ½′
62. Dark-olive, hard, sandy beds, ... 100′
63. *Spirifer bed*, ... 2′
64. Bluish shales, ... 5′
65. *Spirifer bed*, ... 2′
66. Hard, dark, olive, sandy beds, ... 125′

67. Dark-olive sandy beds containing *Chonetes setigerus*, *Pteronites chemungensis*, and *Spirifera mesocostalis*, 30′
68. Dark-olive sandy beds containing *Stictopora*, *Palæoneilo filosa*, *Eudon bellistriatus*, *Cardiomorpha suborbicularis*, *Productella lachrymosa?* and many other forms given in a preceding portion of this report, thickness, . 95′
69. Hard, very sandy, olive-gray beds, no fossils seen, 300′
70. Olive, sandy beds breaking in long splinters, and containing *Leiorhynchus mesocostale*, . 60′
71. Dark olive-brown sandy beds containing *Aulopora tubiformis*, *Spirifera mesocostalis*, *Orthis tulliensis*, and fragments of *Crinoids*, ... 20′
72. Dark olive-brown and bluish hard sandy beds, 175′
73. Dark blue, shaly sandy beds with a hard and slightly limy layer at base, ... 25′
74. *Genesee shale*, a series of dark blue, black, and bluish-gray shales, no fossils seen, ... 275′
75. *Tully limestone*, dark blue on fresh fracture, weathering to a dull ashen-gray or slightly buff tinge, quite fossiliferous at certain horizons, dip 40° S. 10° E., . . . 50′
76. *Hamilton* proper in bed of river at Bloomsburg ferry for 1000′, dip 35°–40°, ... 600′
77. Concealed under north shore of *Susquehanna* river and northward in Bloomsburg township to the *Lower Helderberg limestone* outcrop (or line of strike of those beds) 3000′ horizontally; and, as the dip in the beds above is never less than 35° and often 45°, it would seem a safe limit to assume an average of 30° in these concealed beds, which gives a thickness of 1500

Summary.

Catskill (IX) Nos. 1-24, inclusive,		1412′
Transition IX-VIII, Nos. 25-29, inclusive,		1100′
Chemung, Nos. 30-73, inclusive,	VIII.	2300′
Genesee shale, No. 74,		275′
Tully limestone, No. 75,		50′
Hamilton and Marcellus, Nos. 76-77,		2100′
Total,		7237′

The thickness of the *transition IX-VIII series* of this section is arbitrarily assumed to be about 1100′, since on the opposite side of the Susquehanna below Rupert, in Montour township, the first *Holoptychius remains* come at 1007′ above the *lowest red bed.*

The Chemung beds are very finely exposed in the cuts of the North Branch R. R. The portion below the *Stony Brook beds* was all measured by estimating the thickness of the layers as they rise obliquely above the level of the

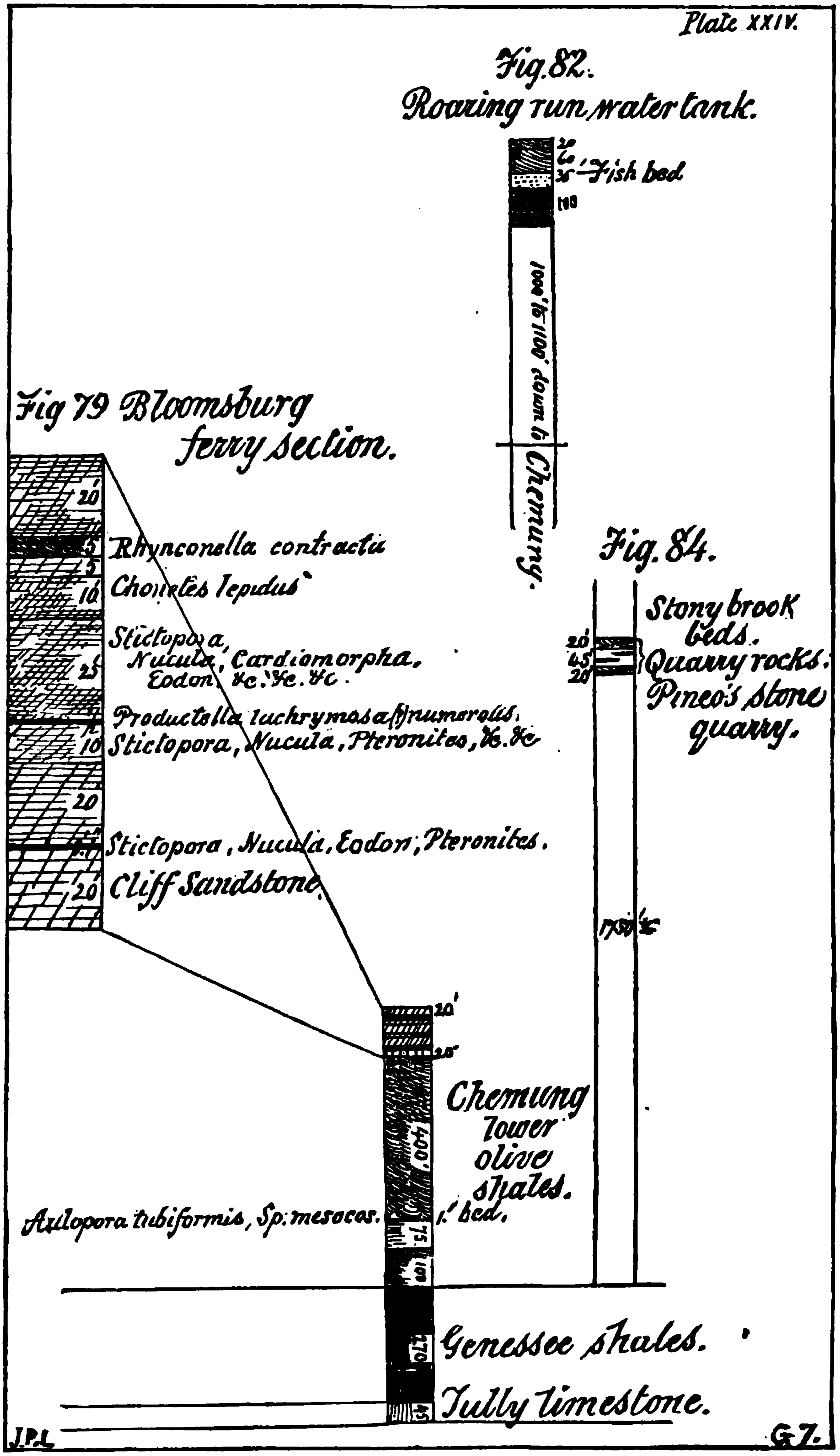

Plate XXIV.
Fig. 82.
Roaring run water tank.
Fish bed
100
1000' to 1100' down to Chemung.
Fig 79 Bloomsburg ferry section.
20
Rhynconella contracta
Chonetes lepidus
Stictopora, Nucula, Cardiomorpha, Eodon, &c. &c. &c.
25
10 Stictopora, Nucula, Pteronites, &c. &c
20
Stictopora, Nucula, Eodon, Pteronites.
20 Cliff Sandstone.
Fig. 84.
Stony brook beds.
20
45
20
Quarry rocks.
Pineo's stone quarry.
1750'
20'
20'
Chemung lower olive shales.
400'
Aulopora tubiformis, Sp: mesocos.
1.' bed.
75
100
Genessee shales.
270
Tully limestone.
45
J.P.L.
G 7.

R. R. in passing north-east along it; hence they may possibly be 75′–100′ too small, or even more; for the interval from the base of the *Stony Brook beds* down to the base of the *Chemung* is generally not less than 1900′ in the other sections taken in this and adjoining counties.

There are several richly fossiliferous horizons in these sandy beds below the *Stony Brook horizon;* and from them Prof. Claypole has identified the lists of fossils given under the general description of the *Chemung rocks* on a previous page (72) to which the reader is referred for a fuller and more minute description of the beds in the above section.

The *Stictopora* given here begins near the base of No. 67, and is found in vast quantities at every few feet up through 800′ of overlying beds, the last observed being near the middle of No. 45.

The Genesee shale, No. 74, was examined here as carefully as my limited time would admit, but no fossils were found in it. On weathering quite long the dark slates of this series bleach almost white.

The Tully limestone, No. 75, contains, according to Prof. Claypole, none of the *Tully* fossils found in New York, but merely the common *Hamilton* forms: *Atrypa reticularis*, *Ambocœlia umbonata*, *Spirifera fimbriata*, *S. ziczac*, *Chonetes setigerus*, *Calymene rana*, *Platyceras sp?* and others not determined.

The upper portion of the *Hamilton* proper contains some fossiliferous streaks at this locality, holding *Atrypa reticularis*, *Spirifera mucronata*, and *S. granulifera.*

Hamilton.—The great thickness (2425′) of the entire *formation* here, as given by the construction, seems excessive, since it is more than double that of the same *formation* only three miles north from here on the north side of the *Montour axis* where none of it is concealed. And yet it can scarcely be less, for no anticlines are seen crossing the rocks anywhere in the district between the *Montour axis* and the syncline next south; so it seems certain that the *Hamilton beds* are much thicker south of the *Montour* axis than north of it.

In descending the small stream which empties into the

Susquehanna river at Bloomsburg ferry, the following section is exposed along the cuttings at the roadside:

Bloomsburg Ferry Section, (Fig. 79, page 288.)

1.	Shaly, greenish sandstone,	20′
2.	Sandy shales and olive-green sandstone, containing *Rhynchonella contracta* in great numbers,	5′
3.	Sandstone, shaly, greenish,	5′
4.	Bluish, sandy beds, quite fossiliferous, (*Chonetes lepidus*,)	10′
5.	Greenish-gray and bluish-green sandy beds, containing *Stictopora*, *Nucula*, *Cardiomorpha*, *Eodon*, and many other forms,	25′
6.	Greenish-yellow sandy beds containing great numbers of *Productella lachrymosa?*	0′ 6″
7.	Bluish-green sandy beds containing *Stictopora*, *Nucula*, *Pteronites*- and many other badly preserved fossils,	10′
8.	Bluish-gray hard flaggy sandstones,	20′
9.	Thin layer filled with *Stictopora*, *Eodon*, *Nucula*, and *Pteronites*,	0′ 1
10.	Dark-gray, sandy, massive beds, making cliffs,	20′
11.	Concealed, and dark olive and gray, sandy beds,	400
12.	Layer filled with *Aulopora tubiformis* and *Spirifera mesocostalis*,	1′
13.	Concealed, and hard, grayish, sandy beds,	75′
14.	Dark gray and olive sandy shales, and shaly sandstones to *base* of *Chemung beds*,	100′
15.	*Genesee shales*,	270′
16.	*Tully limestone*,	45′

The rocks of this section dip S. 10°–15° E. 40°–45.

No. 2 to 10. The fossiliferous beds (with the exception of the *Aulopora* horizon,) extend from about 600′ above the base of the Chemung, through 95′ of rock. They are the equivalents of Nos. 67 and 68 of the preceding section.

From several horizons in this 95′ of rock (Nos. 2–10) I collected the following species of fossils which were identified by Prof. Claypole:

Eodon bellistriatus, *Cardiomorpha suborbicularis*, *Nucula* two species not determined, *Palæoneilo filosa*, *Chonetes lepidus*, *Spirifera mesostrialis*, *S. mesocostalis*, *Productella lachrymosa?*

The close agreement of the measurement of the *Genesee shale* in this section (270′) with that of the preceding one (275′) lends additional confidence to the substantial accuracy of both.

The top of the *Chemung* ends on the summit of the ridge south from Bloomsburg ferry at the by-road leading to Mr. J. Kieffer's, thus making the outcrop of these beds about 275 rods in breadth.

The Catskill beds cover all the southern portion of the township.

Barometric elevations in Catawissa.

	A. T.
Susquehanna river at Bloomsburg ferry,	451′
Forks of road 256 rods south of last,	910′
" " near B. Miller's,	850′
" " 25 rods south of last,	855′

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57. *Franklin township.*

This township is situated next west from Catawissa, in the angle of Montour and Northumberland counties.

Roaring creek flows across it (from east to west) just south of its center, and then veering northward flows between it and Montour county to the Susquehanna.

The Northumberland syncline passes through the northern half of the township towards and into the projecting double spur of the Catawissa mountain. This basin is obscured by *drift deposits.*

High drift.—Such bowlder deposits occur on the summit of the ridge at the cemetery near Mr. J. John's, where great heaps of rounded bowlders of *Pocono*, and *Pottsville conglomerate* are seen at 950′ A. T. With these are many bowlders of *Catskill;* and also much sand and finer trash. This locality is on the highest part of the dividing ridge between the Susquehanna river and Roaring creek. I could find no evidence of *Glacial action.*

The Catskill and *Catskill-Chemung beds* cover all of Franklin township north from Roaring creek; but south from it the rapid (30°–40°) southward rise of the rocks brings up the *Chemung beds* over a considerable portion of that area.

The lowest red bed of the Catskill-Chemung is seen just

south from the forks of the road near Kistler's mill, where the rocks at the top of the *Chemung*, dip N. 10° W. 40°.

The Chemung beds are not well exposed anywhere in Franklin; but along the south branch of Roaring creek the exposures are good for short distances.

Barometric elevations in Franklin.

	A. T.
Roaring creek at eastern line of the township, ...	630'
Forks of road north from W. Stoker's, ...	910'
" " " near J. John's, ...	950'

---

58. *Locust township.*

This township lies south of Franklin and Catawissa, bounded on the west and south by Northumberland county, and between the north and south branches of Roaring creek.

Little mountain is a straight, lofty ridge of *Pocono rocks* dipping south along the southern line of the township for half its length. Then the line cuts southward across the *red shale valley* of South Fishing creek and runs the rest of its course, westward, along the crest of *Big mountain*, a similar straight and lofty ridge of *Pottsville conglomerate rocks*, dipping south, under the Shamokin coal basin.

The south branch of Roaring creek cuts square through Little mountain at the south-west corner of Locust, exposing the *Pocono* and *transition IX–X beds* in a series of cliffs dipping rapidly (40°) southward. This is known as *Bear Gap.*

The Selinsgrove axis passes through the township just south from its center, with north and south dips of 30°–40°.

The crest of this arch crosses the south branch of Roaring creek near the mouth of the small run just west from J. Campbell's, where it brings the top of the *Hamilton formation* above water-level in a narrow valley expanding toward the west; but, overridden and covered up by the *Chemung beds* toward the east; in which direction the *Catskill beds* cover up the *Chemung* on the crest of the arch.

The Catskill beds make a valley nearly one mile broad

along the northern border of Little Mountain; and then further north the hard beds of the *Lower Chemung* come up in a high ridge through which South Roaring creek cuts a wild cañon between P. M. Yocum's and Mrs. F. Walter's.

The East Br. of Roaring creek flows in the *transition VIII–IX beds* along the northern line of the township west from Slabtown, and they are seen at the forks of the road near M. Hower's dipping N. 10° W. 40°.

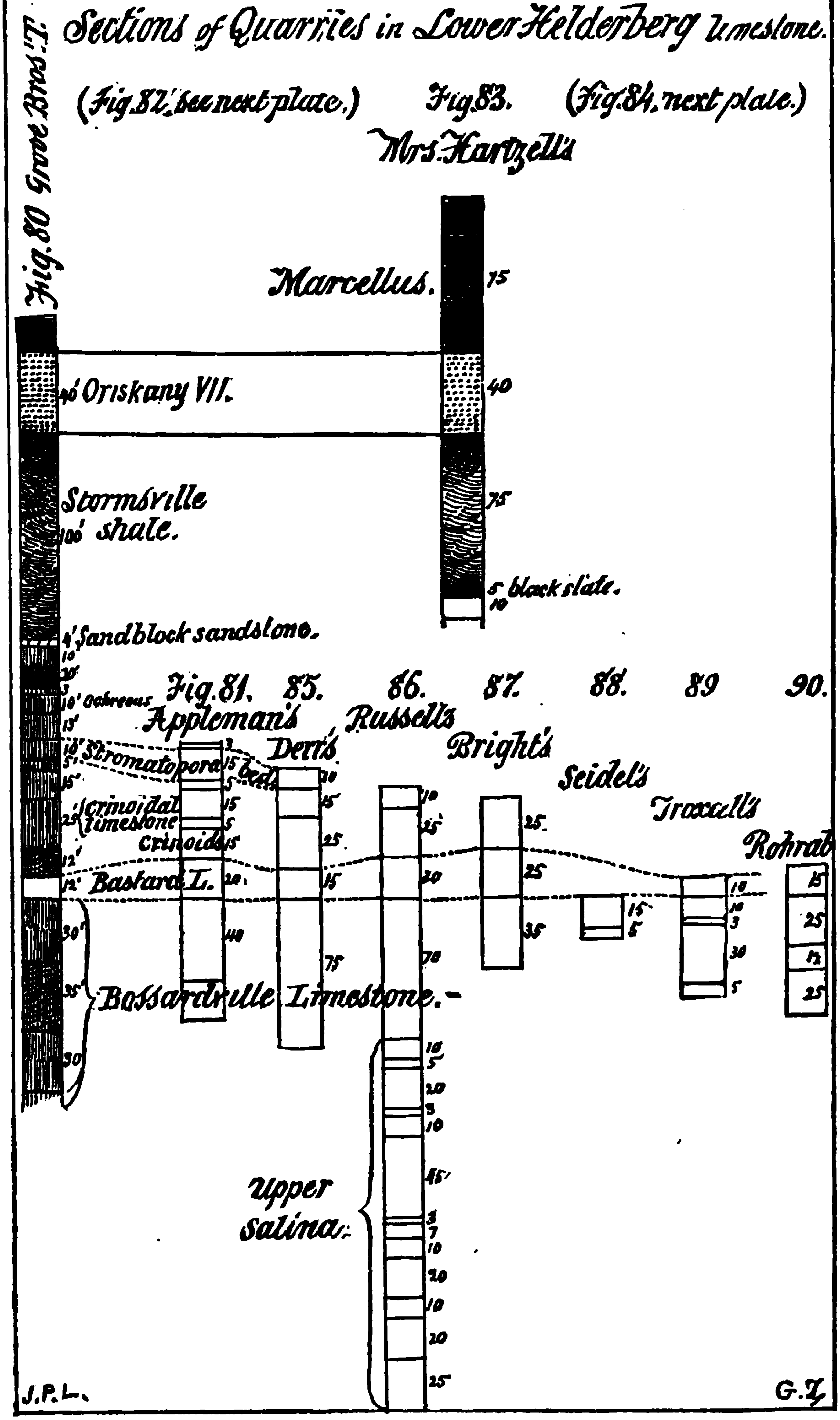
The Chemung rocks first rise above South Roaring creek (in descending it,) where the creek road crosses a little stream one half mile below Bear Gap P. O., and just east from W. Billman's.

The transition VIII–IX red and olive shales are seen near P. Yocum's store and southward, dipping 50°–55° S. 10° E.

Barometric elevations in Locust.

	A. T.
South Roaring creek at W. Hummel's,	**780'**
Forks of road near P. M. Yocum's,	**735'**
South Roaring creek at crossing next below,	**715'**
Forks of road near Mrs. F. Walter's,	**690'**
" " next north,	**675'**
South Roaring creek here,	**650'**
Forks of road near A. M. Johnson's,	**730'**
Mugser's creek next north at crossing,	**680'**
Forks of road near I. N. Teitsworth's,	**835'**
" " at School-house 64 rods north,	**875'**
" " 90 rods N. E. of last,	**1040'**
Cross-roads near E. George's,	**985'**
Forks of road north-west of M. Hower's,	**665'**

Plate XXV.


Sections of Quarries in Lower Helderberg Limestone.
(Fig. 82, see next plate.)
Fig. 83.
(Fig. 84, next plate.)
Mrs. Hartzell's
Fig. 80 Grove Bros.' T.
Marcellus.
40' Oriskany VII.
Stormville
100' shale.
black slate.
4' Sandblock sandstone.
10' Ochreous
Fig. 81.
85.
86.
87.
88.
89
90.
Appleman's
Russell's
Derr's
Bright's
Seidel's
Troxall's
Rohrab
Stromatopora bed
Crinoidal limestone
Crinoids
Bastard L.
Bossardville Limestone.
Upper Salina.
J.P.L.
G.L.

CHAPTER X.

Township Geology of Montour.

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59. Cooper township.

This is a small area on the north bank of the Susquehanna river, adjoining Columbia county. The northern half drains westward through Mahoning township to the North Branch Susquehanna at Danville, while the southern half drains directly south into the latter stream by means of several small brooks.

The Montour axis (along the extreme northern line of the township) elevates the south-dipping *Clinton beds* of Montour Ridge; the river flowing along the strike of the *Catskill beds*. A ridge along its southern border is made by the *Chemung hard sandstones;* a broad valley (*Hamilton-Salina*) extends through the center.

The old buried valley (described under Montour township in Columbia county as trending westward from the Susquehanna valley after the latter turns southward through the gap of the *Chemung rocks* at Rupert) continues westward along the strike of the *Hamilton beds* through this township. The water-shed of the valley is a wide plain covered deeply with bowlder trash, and is found about one half mile west from the eastern line. The Catawissa Br. of the Reading R. R. passes along this valley, and its summit occurs at 615′ A. T., or only 165′ above the level of the Susquehanna river at Rupert.

A low ridge of *Lower Helderberg limestone* runs parallel with the Hamilton valley on the north.

North of this ridge is a broad valley of *Salina.*

The Clinton fossil ore comes up to the surface along the southern foot slope of Montour Ridge and has been mined

on the lands of Messrs. Snyder, Knorr and others to a considerable extent, though none of the workings are in operation now.

The outcrop of this ore is nearly one half mile south from the northern line of the township.

The Salina rocks are mostly concealed under the surface dèbris which covers up the valley along their strike.

The Lower Helderberg limestone is extensively quarried at the eastern line of this township by the Grove Bros., of Danville. In order to drain the quarry and afford a more convenient outlet to the R. R. for the limestone, a long *tunnel* has recently been completed at this quarry. It begins in the *Marcellus beds* and extends almost squarely across the strike of the rocks through the center of the *Lower Helderberg limestone*, revealing the structure:

Section in the Grove Bros'. tunnel (Fig. 80, page 294.)

1. *Marcellus* yellowish-gray shales,	—
2. *Oriskany*, a series of impure, cherty, fossiliferous beds of a dirty yellowish cast,	40'
3. Black shales with thin beds of impure limestone, representing the *Stormville shale* of Pike and Monroe,	100'
4. Very hard calcareo-silicious sandstone at times almost a pure quartzite, called "sand block" by the miners, contains *Spirifera arenosa*, and represents the *Stormville conglomerate* of Pike and Monroe; thickness,	4'
5. Dark-blue limestone, good,	10'
6. Limy shales and shaly limestone,	20'
7. Limestone, blue, good,	3'
8. Limestone, buffish, orchrey on weathered surface and crumbling on exposure,	10'
9. Limy shales and shaly limestone,	13'
10. *Stromatopora bed*, a very hard, tough bluish-gray limestone,	10'
11. Bluish, impure, shaly limestone.	5'
12. Limestone, dark blue, crystalline, all quarried,	15'
13. Very massive, somewhat sandy limestone, contains many *crinoidal remains*,	25'
14. Bluish shaly limestone,	12'
15. "*Bastard limestone*,"	12'
16. Dark blue and blackish limestone top of *Bossardville beds*,	30'
17. Shelly limestone impure,	35'
18. Bluish-gray limestone, good, seen down nearly to base of the Bossardville beds,	30'

Summary of the section.

Oriskany,	40′
Stormville shale,	100′
Stormville conglomerate,	4′
Stormville limestone, Nos. 5–14, inclusive, with *Stromatopora bed* in center,	111′
Nos. 14 and 15, *Stormville cement beds* and *Decker's ferry group*,	24′
Bossardville limestone, Nos. 16–18,	95′
Total of the section,	374′

If to this we should add the thickness of limestone concealed down to the *Salina* it would make nearly 400′ for the interval from the top of the *Oriskany* to the base of the *Lower Helderberg;* which is almost exactly the thickness of these beds in Pike and Monroe (excluding therefrom the 200′ of *Poxono shales and limestones* (*Salina*) which in G⁶ were included with the *Lower Helderberg*, thus making the series as given on page 130 G⁶, 200′ thicker than it should be.)

The Oriskany is a mass of impure chert, having interstratified with it a few thin layers of dirty yellow, rotten sandstone. These beds were encountered about half way through the tunnel, (which is 235 yards long and the rocks dip S. 10 E. 40°–45°,) but they occur in a part of it which had been walled up and arched before my visit; hence the thickness of the Oriskany as given here was not obtained at the tunnel, but at an exposure along the road two miles west. The outcrop of the *Oriskany* on the surface is here covered by soil and other débris; but from the place where it was struck in the tunnel, and also from a well dug near, it is known that the outcrop is just south from the Danville road.

In the *Oriskany débris* taken out of the well and in that from the tunnel found on the dump the following fossils occur according to the identifications of Prof. Claypole:

Spirifera arrecta, *S. submucronata*, *S. arenosa*, *Platyceras magnificum*, *P. ventricosum*, *P. tortuosum*, *Discina ampla*, *Orthis musculosa*, *Leptocœlia flabelites*, *Rensælaria ovalis*, *Rhychonella oblata.*

The aspect of the *Oriskany* is so much like the *Cornif-*

erous in Pike and Monroe that I was at first inclined to identify these beds of No. 2 with the *Corniferous*, since the lithology is almost exactly like that of the *Corniferous limestone* at many localities in Pike and Monroe, and in addition its most abundant fossil is *Spirifer arrecta* a Corniferous species. But this list of fossils would seem to settle the matter in favor of the *Oriskany* even had I not subsequently traced the deposit into other portions of the district and found it changing into the typical *Oriskany sandstone*. It should also be remembered in this connection that the *Oriskany* is full of chert in Pike and Monroe counties. (See section on page 125, G⁶.)

The Stormville shale is quite well exposed in the tunnel, where it is seen to consist largely of blackish-brown shales interstratified with which are some layers of light-gray impure limestone, thus presenting a strong contrast to its lithological character in Pike and Monroe, where it is usually an ashen-gray, sandy shale very much resembling the *Cauda galli grit*. Some layers of the black shale in the tunnel contain a curious looking *fucoid* with flattened stems ¼″–½″ broad, braching quite irregularly and resembling *Buthotrephis*. *Strophomena rugosa* and *Spirifera macropleura* occur in the limestone layers of this shale.

A bed of rather pure dark-blue limestone 6′–8′ thick is found at the very base of the *Stormville shale*.

The Stormville conglomerate of Pike and Monroe seems to be represented beyond doubt by No. 4 of the section, a calcareo-silicious rock which contains coarse sand grains in some portions, is a compact quartzite in others, and occasionally passes into *chert*. The miners found it a very hard rock to tunnel through, "as hard as granite," said one, and they termed it the "*Sand block*," since it comes out in more or less rectangular portions. As obtained from the tunnel (where it has been totally excluded from atmospheric action) this bed presents quite a different appearance from its weathered aspect seen along the crest of the limestone ridge, where the lime has been almost wholly removed by solution, leaving the sand grains standing out prominently on some portions, so as to make it almost pebbly, while the

finer, compact quartzite is often left in a cellular condition like chert. In these sandstone portions I found some internal casts of *Spirifera arenosa*, or at least a form not distinguishable from it.

The Stormville limestone of Pike and Monroe counties is represented by Nos. 5–13, a group of fossiliferous beds 111′ thick, with a fossil reef of *Stromatoporæ* and other fossils near the center, an exact counterpart of the *Stromatopora bed* found near the center of the *Stormville limestone* at the eastern line of Pike county and westward to the Delaware Water Gap in Monroe.

The thickness of this *Stormville limestone* in Pike and Monroe (100′) also corresponds very closely with that of the same series in the section given above, viz: 111′.

The limestone quarried here is used for flux in the furnaces of the Grove Bros. at Danville, and only about two thirds of these Stormville limestones are pure enough for such purposes; No. 13 being especially sandy, and too impure for flux except when mixed with much purer limestones.

The Stormville cement bed and *Decker's ferry group* are represented by Nos. 14 and 15; the *Bastard limestone* of the quarrymen being somewhat magnesian and of a buffish-gray color on weathered surfaces, very much resembling the *Stormville cement bed* of Pike and Monroe.

The *Decker's ferry sandstone* of Monroe county does not occur in this section, but neither does it at the eastern line of Pike.

The *Bossardville limestone* Nos. 16–18 are also here marked by the same purity, the same flag-like structure, the blackish-blue color, and almost total absence of fossils, as in Monroe county.

No. 16 is the purest limestone in the *Lower Helderberg series* at this locality, and is highly valued as a flux.

On below the *Bossardville limestone* at this locality there come the buffish-gray and pale green impure magnesian limestones of the *Upper Salina*, and further north the red shales of this group come in and are seen making red streaks

of soil in the ploughed fields along the valley which the *Salina beds* form at this locality.

The Oriskany beds are exposed in a cutting on a by-road a short distance west from Grove's quarry near Mr. J. J. Blecker's, where 10′ of the blackish, flinty layers are visible, dipping S. 10° E. 30°–40°.

About one half mile west from the quarry of Grove Bros. the *Lower Helderberg limestone* is again quarried on the land of Mr. M. S. Appleman by Mr. Christy and others where the following section was obtained:

Section on M. S. Appleman's land, (Fig. 81, page 294.)

1. *Shaly limestone,*	3′
2. *Stromatopora bed,*	15′
3. Shaly limestone,	5′
4. Limestone, bluish-gray, fossiliferous,	15′
5. Rather sandy, gray limestone,	5′
6. Limestone, bluish-gray, filled with *crinoidal fragments,*	15′
7. *Bastard limestone,*	20′
8. Dark blue limestone top of *Bossardville,*	40′
9. Bluish gray, shaly limestone, impure, visible	10′

These limestones make a ridge here. The *Hamilton valley* just south of it has an elevation of 615′ A. T. at its highest; the *Salina* valley north of it 660′; the ridge between nearly 700′ A. T.

The *Stromatopora bed* is a great fossil reef of *Stromatopora concentrica* at this locality, and it makes a bold massive cliff along the top of the quarry.

No. 4 also contains a great number of *corals, Favosites, Zaphrentis, Cladopora, Conophyllum* and many *Stromatoporæ.*

No. 6 contains vast quantities of *crinoidal fragments,* together with *Cladopora* and other fossils.

None of these beds above the "Bastard limestone" are pure, but all contain much silicious material; and some of the *Stromatoporæ* in No. 2 appear to be silicified.

No. 9 is the main quarry rock, since it is quite pure and burns into a beautiful white lime. It has been dug out of the hill in a long trench, (since the beds dip S. 10° E. 35°–40°,) leaving the "Bastard limestone" overhanging it above and the impure shelly layers coming up steeply below. It

is known as the "*main bench.*" No fossils were seen in it, but many veins of calcite radiate through its dark mass.

The Lower Helderberg ridge sinks down west from the last locality, and the two valleys come together at P. Faust's, where no limestone is to be seen. The farmers generally believe that it "runs out," because it disappears so suddenly, and does not come in again to the west for a considerable distance. The true cause of disappearance, however, is to be found in the fact that a stream comes down from the north at this point and, cutting across into the old Hamilton valley, has eroded the limestone, which could be found by digging to the proper depth, which may be 50′ or 60′.

The Lower Helderberg limestone rises to view again at the forks of the road near W. York's, and has there been quarried and burned at the roadside, where we see the *Stromatopora bed*, and about 15′ of the underlying limestones; the *Bastard limestone* and *Bossardville group* all being concealed under the valley at the north.

In passing on westward from this the *L. H. limestone* is constantly covered up by débris until we pass into Mahoning township.

The *Oriskany* makes a low ridge just south from the outcrop of the *Lower Helderberg limestone* at the western line of this area, though its rocks are concealed by soil and other débris.

The Hamilton beds, as already stated, are entirely concealed beneath the buried valley which follows the strike of these rocks through this township.

At the southern edge of the buried valley the surface begins to slope upward; and this betokens the presence of the hard *Chemung rocks* which rise into a ridge 800′-900′ A. T. and 200′-300′ higher than the valley. The breadth of the Hamilton belt in this township is not far from 3000′, and this would give a thickness of near 2000′ if we can depend on constancy of dip, which is 40°-45° in the underlying rocks in the Grove tunnel, and also the same in the *Chemung* above.

As no streams cut through the *Chemung ridge* the rocks

of this series are nearly all concealed within this township, at least nothing like a continuous section can be obtained. They extend, however, to within about 200′ rods of the Susquehanna river, where the *transition series VIII–IX* comes down, and finally the genuine *Catskill*, in the top of which the river flows along the southern line.

The base of the *Chemung-Catskill beds* occurs on the road which leads northward from the river at the eastern line of the township near the forks of the road at W. Erwine's.

Roaring run puts into the Susquehanna about one third mile east from the western line of this township, and where the D. L. & W. R. R. crosses it the following section is seen in the vicinity of the Water tank:

Section on D. L. & W. R. R. at Roaring run water tank,
(Fig. 82, page 288.)

1. Shales containing hard, brown fossiliferous sandy beds ½′–3′ thick,	20′
2. Light olive and yellowish shales,	60′
3. Very coarse greenish gray massive conglomerate, containing large *fish-bones*,	35′
4. Concealed and *red shales*,	100′
	215′

No. 1. The brown sandy beds contain numerous *crinoidal fragments* and *Spirifers*, together with a minute *Tentaculite* which much resembles *T. spicula.*

The rocks in which these occur have a reddish-brown cast, and two systems of joints traversing them at nearly right angles split up the beds into prismatic blocks of varying size.

No. 2 is a soft olive-yellow shale, and contains some fossil *Spirifers* apparently a variety of *S. disjuncta.*

No. 3. *The conglomerate* is a very curious stratum, containing immense quantities of large rounded quartz pebbles and *fish bones*, some of which are more than an inch in diameter. The matrix is a coarse greenish-gray sand, and the stratum evidently belongs in the *Catskill*, as attested by the abundant remains of *large fish* and also by its position at least 1000′–1200′ above the base of the *transition*

IX–VIII series. A very coarse massive sandstone occurs in the township (Montour) east from this one at 1100′ above the base of the *transition IX–VIII beds*, and it, too, has large *fish bones* imbedded, so that they are very possibly identical, though no quartz pebbles occur in the Montour stratum. In fact this is the only locality within the district where I have found a *conglomerate* within several hundred feet of this horizon. It seems referable to the *Lackawaxen conglomerate* of Pike county which is only locally conglomeratic.

This stratum makes a great bare platform of massive rock dipping 35°–40° S. 10° E. on both sides of Roaring run at the water tank, and massive cliffs crop out along the same for a short distance where the run has cut through it.

A *stone quarry* was once operated in *Catskill beds* on the D. L. & W. R. R. near the eastern margin of the township. The rock is a greenish-brown sandstone, 6′–8′ thick, and rests on yellowish-olive shale streaked with red, the whole dipping S. 10° E. 45°.

In the vicinity of the last section a bed of very hard *Catskill sandstone* 100′–200′ above the *conglomerate* makes a long line of outcrop nearly half way across the Susquehanna river, its projecting beds rising from 2′–3′ above low water, broken by intermediate submerged portions and extending very obliquely with the current of the stream which is here cutting northward from the strike of the rocks.

Barometric elevations in Cooper.

	A. T.
Forks of road near Grove Bros.' quarry,	640′
Level of Reading R. R. at crossing just south,	600′
Summit in old valley one half mile west from eastern line of township,	615′
Danville road at by-road to H. Westman's,	680′
" " J. Hartman's,	680′
" at School-house No. 1,	660′
" at stream near P. Karchner's,	645′
" at forks near York's limestone quarry,	665′
Forks of road at south-east corner of township,	475′
" " next north,	510′
" " near B. Baylor's,	730′
" " at St. Peter's church,	745′
Summit of Chemung ridge in gap 10 rods south of last,	755′
By-road to D. Mowery's,	685′

60. *Mahoning township.*

This township lies directly west from Cooper, on the north bank of the river. The western neck of the township has Northumberland county for its southern boundary.

This area has the same rocks and structure as Cooper township, the same high ridge (Montour) of *Clinton rocks* along its northern line; a valley of *Salina*, *Lower Helderberg* and *Hamilton* through its center, a ridge of *Chemung* along its southern portion, while the *transition* (VIII–IX) and *Catskill beds* make the banks and bed of the river.

About two miles above the mouth of Mahoning creek the river veers north-westward, and cuts through all the formations from the Chemung to the base of the *Clinton;* exposing just west from Danville the top of the *Medina.*

The Clinton fossil ore comes up about 200 rods south from the northern line of the township, and has been mined on the lands of Messrs. Simmons, Morrison, Faust, and others. It, like all the rest of the rocks of the township, dips rapidly southward and is soon buried deeply under the *Salina valley;* while northward it arches into the air over the crest of Montour ridge, which rises 400′–500′ above the wide valley along its base. Mahoning creek which has given name to the township trenches squarely through this ridge in a deep, narrow channel and empties into the Susquehanna river at Danville, the county seat of Montour.

The Clinton and *Salina beds* are partially exposed along the gap of Mahoning creek through Montour ridge, but no detailed section could be obtained.

The Lower Helderberg limestone is completely concealed under the great thickness of surface débris which fills the old buried valley that extends westward through this township from Cooper, and debouches into the Susquehanna at Danville. Much of this débris consists of angular fragments of sandstone and sandy slate much resembling that from the lower *Clinton beds* along the crest of Montour ridge; and it is quite possible that this was its origin, the material having been transported out over the valley by landslides and other natural shiftings of rocky débris from steep slopes.

The Oriskany cherty beds make a sharp low ridge from the eastern line of the township nearly to Danville, just south from the Bloomsburg road; and just north from it the *Stormville shales* are frequently exposed for short distances.

The roads which pass over this *Oriskany ridge* are usually cut down several feet into its crest, since the descent is very steep on the south side toward the old Hamilton valley.

Along the road which leads southward over this ridge from Mrs. Hartzell's, at the eastern line of the township, the following was obtained:

Section near Mrs. Hartzell's, (Fig. 83, page 294.)

1.	Shales, grayish, getting darker toward base,	75′
2.	*Oriskany beds*, completely exposed, and consisting of dark, cherty layers 3″–8″ thick, with yellowish sandy beds at top which are quite fossiliferous, *Platyceras*, *Spirifera arenosa*, and *S. arrecta* being quite common,	40′
3.	Ashen gray slaty beds,	75′
4.	Black slate,	5′
5.	Gray shales,	10′
6.	Concealed to forks of road near Mrs. Hartzell's 240′ dip 40°–45°,	150′
		355′

No. 1 would of course belong to the *Marcellus* unless the *Cauda galli beds* be *present*. It is well exposed at Mr. J. Westman's barn where in grading for the foundation it was uncovered.

No. 2. The dip is so steep here (40°–45°—S. 10° E.) that when the *Oriskany chert* shoots into the air it makes a very sharp ridge much like the comb of a steep roof, and is called the "hog-back" by the people in the vicinity. This stratum is completely exposed here by the cutting necessary to grade the road across the sharp ridge. The most of this *Oriskany* is a blackish, cherty, limy deposit almost exactly like the *Corniferous beds* in Pike and Monroe; but near the top these beds of the section become more sandy, have a yellowish color, and are filled with the *Oriskany* fossil, *Spirifera arenosa*.

Nos. 3–5. *The Stormville shale* is represented by a series of ashen gray shales which become blackish toward the base of the portion visible. It is possible that the other beds were more or less blackish before having been bleached by exposure to atmospheric influences. The thickness (90′) of the shale exposed here shows that the *Lower Helderberg limestone* must come in very near the top of No. 5, since the *Stormville shale* is seldom more than 100′ thick in this district. The limestone, however, makes no show on the surface and it has most probably been removed by solution and otherwise to a considerable depth below the surface.

On west from this last locality, a little more than one half mile, another road leads from the Bloomsburg pike southward across the *Oriskany ridge* to the Danville Poor House. *The Stormville shale* is first exposed at 550′ south from the pike, and the outcrop of the *Oriskany chert* comes in on the crest of the sharp ridge 150′ further south, the dip being about 30° S. 10° E.

On west from the last locality about 100 rods another road leads south from the Bloomsburg and Danville pike, and on it the *Stormville shale* is first seen at 500′ south from the pike. It has an ashen gray color and dips rapidly south, 40′–50′ of its upper portion being visible up to the crest of the sharp ridge where the *Oriskany chert* comes down and is well exposed on south to where the road turns sharply west.

A broad valley (¾ m. wide) stretches north of this *Oriskany ridge*, with an elevation 50′ lower.

South of the ridge the surface slopes down rapidly to the old buried Hamilton valley 125′ lower than the crest of the ridge.

The Lower Helderberg limestone is seen in the bed of the Susquehanna river near its south shore, under the bridge connecting Danville with South Danville. The bluish gray, shaly limestones for 25′–30′ at the top of the series are here exposed, and above them the *Stormville shale.*

The Hamilton beds are everywhere covered up in this

township except along the D. L. & W. R. R. above Danville, where a few outcrops may be seen.

The Chemung rocks are cut through by the Susquehanna river where it turns north-westward towards Danville and they are frequently exposed along the D. L. & W. R. R. in the vicinity of the Danville Insane Asylum and eastward.

Rock dam. Near the Asylum a ledge of very hard rocks in the *Lower Chemung* extends almost entirely across the present channel of the river standing 1′–2′ above low water in a series of projections interrupted by submerged portions.

The Pineo stone quarry is situated in the upper *Chemung* beds about two miles above Danville station, and there the following section was observed:

Section at Pineo's stone quarry (Fig. 84, page 288).

1. Shales, sandy, yellowish-green,		20′
2. Quarry stone, bluish, micaceous, in layers 6″–24″ thick,		45′
3. Dark bluish, sandy shale,	visible	5′
		70′

No. 2 is the quarry portion, and from it a vast amount of stone for building and other purposes has here been obtained. The beds dip S. 10° E. 30°, and the entire face of the hill for more than an acre in surface has been uncovered at the quarry. The rock is seemingly destitute of fossils except some vegetable fragments which resemble *Psilophyton princeps*, Dawson.

This quarry rock comes below the base of the *Stony Brook beds* or say 1750′ above the base of the *Chemung;* since on passing further eastward along the D., L. & W. R. R. we come to the *Stony Brook fossiliferous beds* at about 100′ above No. 1 of the section.

These Stony Brook beds are finely exposed in the vicinity of the Penna. canal lock, a short distance east from the Pineo quarry; and, as the R. R. here makes a very small angle with the strike of the rocks, a large exposure (the best in the district) of these fossiliferous beds extends along the track for several rods. From this locality Prof. Claypole and myself collected the following species which were identified by Prof. C. as follows: *Productella hirsuta, P.*

hirsuta rectispina, *Spirifera mesocostalis*, *S. disjuncta*, *Leiorhynchus globuliforme*, *L. mesocostale*, *Discina media*, *Streptorhyncus chemungense*, *Bellerophon macra*, *Goniatites discoidens?*

The most abundant forms are *Productella hirsuta*, *Leiorhynchus mesocostale*, and *Spirifera disjuncta*, with *S. mesocostalis*.

Barometric elevations in Mahoning.

Bloomsville and Danville pike at forks of road near the eastern line of the township,	650′
Road at crossing of run next west,	625′
" " " "	635′
Danville road at forks near Mechanicksville school-house,	600′
Summit of Oriskany ridge just south,	650′
Susquehanna river at Danville,	435′

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61. Liberty township.

This lies next west from the extreme western point of Mahoning, and is bordered by Northumberland county on the west and south.

Chillisquaque creek flows across its northern border from east to west and carries the most of its rain-fall into the West Susquehanna in Northumberland county.

This township is bounded by two ridges, *Montour* on the south and *Lime ridge* on the north; while two broad valleys, one bordering each of these ridges, extend across it.

The Lackawanna synclinal (between the *Montour anticlinal* and the *Milton anticlinal*) fills the township with the basal beds of the *Chemung*.

The lowest beds of the *Clinton* or *Lower olive slates* make Montour ridge, while the *Oriskany chert* and the underlying massive *Lower Helderberg limestone* make Lime ridge.

The Clinton fossil ore has not been mined in this township so far as I could learn, and its outcrop is almost constantly covered up by great piles of rock débris which have come down from the summit and slopes of Montour ridge above. Much of this débris consists of angular fragments of a yel-

lowish-gray or often greenish-gray thinly-bedded sandstone which has come from the *Lower olive slate* at the base of the *Clinton.* It may be that the *fossil ore* is absent through this township; but from its persistence between Bloomsburg and Danville on the north slope of the Berwick axis one would scarcely expect to find it altogether absent at the same horizon in this township.

The Lower Helderberg limestone crops out in several localities in the old valley which extends along the northern foot of Montour ridge.

It rises in a high ledge near the eastern township line just south from the Reading R. R., and is there quarried on the land of Mr. Hugh McWilliams. The *Bossardville beds* are the ones quarried, and they have the dark blue flaggy aspect so common to them elsewhere.

These same beds have also been quarried near the western line of the township on the land of Mr. Moody.

The Hamilton rocks spread across the basin at the western line, the *Chemung beds* having been eroded; but as we come eastward the surface rises and a sharp ridge of *Lower Chemung beds* makes its appearance in the center of the basin, near Mr. Thos. Perry's, almost exactly in the center of the township. This *Chemung ridge* widens as a tongue-shaped mass eastward; the Hamilton rocks bifurcate; one prong passing north-east and making Chillisquaque valley; the other passes south of the *Chemung hills*, and makes the old valley in which Mooresburg is situated.

The line of the *Lackawanna synclinal axis* passes about 200 yards north from the cross-roads at Thos. Perry's; for there *Hamilton shales* dip southward; but at the cross-roads the dip is reversed and the beds pitch gently northward.

Going south, to near Andrew Robison's the dip is reversed to the north, but only for a short distance, over a local roll.

The Tully limestone occurs in the road at the eastern line of the township, one mile south from Chillisquaque creek, and just north from the forks of the road near Mr. Davis'. Here we see 20′ of shaly limestone, ashen-gray on its weathered surface, but dark blue on fresh fracture. The

beds are quite fossiliferous, containing *Ambocœlia umbonata*, *Dalmanites calliteles*, and other fragmentary remains.

The Genesee shale is also exposed for a short distance above the limestone, and is a bluish-black slaty shale.

The Hamilton proper, consisting of dark, sandy shales, is exposed for a few feet below the *Tully limestone*, and then the surface débris covers up everything until we come to Chillisquaque creek, near Mr. G. Boyer's, where the *Oriskany sandstone* rises from the bed of the stream, making a long gentle slope northward to the of *Lime ridge.*

Chillisquaque creek washes the top of the *Oriskany* at many places along the northern portion of this township, and the strike of these beds seems to have determined the course of the stream.

The upper layers of the *Oriskany* are quite sandy, as they appear along Chillisquaque creek and the long southern slope of Lime ridge, having a dirty yellowish color, and only occasionally becoming cherty; so that the rock can with some propriety be termed a sandstone for 10′–15′ at top. Below this, however, the blackish cherty beds appear much like those seen in Mahoning township south from the Montour axis. The entire bed seems to be 40′–50′ thick and is fossiliferous throughout, *Spirifera arenosa*, *Platyceras ventricosum*, and *Rensselæria ovalis* being seen, together with numerous fragments of other shells.

The east and west road which extends through the whole length of the township, just north from Chillisquaque creek, runs nearly all the way on the *Oriskany*, and its fragments are seen scattered over the surface almost continually.

The Stormville shales are also occasionally seen along this road when streams cut across it and through the *Oriskany*. These shales have a dark color and make a blackish outcrop.

The crest of *Limestone ridge* has a general elevation of 700′–750′ A. T., or about 250′ above the level of Chillisquaque creek. Only one stream cuts through this ridge, entering Chillisquaque creek near the center of the town-

ship, trenching a deep, narrow valley directly through the ridge and exposing the *Oriskany sandstone* and underlying beds along its sides.

The Oriskany is seen at the cross-roads near J. Umpstead's, where the east and west road crosses the stream, and has there been quarried for *building stone.* It comes in layers 4″–8″ thick and is a limy sandstone of dirty yellow color, containing some nodules of impure chert.

In passing northward up the little stream that has cut through Limestone ridge, we see the dark *Stormville shales* slightly exposed along the road; and just opposite Mr. Daniel Derr's the *Lower Helderberg limestone* comes up, and there at the quarry the following succession was observed:

Daniel Derr's quarry (Fig. 85, page 294.)

1. *Stromatopora bed*,	10
2. Limy shales and shaly limestone,	15′
3. *Limestone*, massive, gray, fossiliferous,	25′
4. "Bastard limestone,"	15′
5. *Bossardville limestone*, dark-blue or blackish, in thin layers, (visible,)	75′
	140′

No. 1 is a very massive bed of bluish-gray, rather sandy limestone in which vast numbers of *Stromatopora concentrica* and other fossil corals occur. It is certainly identical with the *Stromatopora bed* seen south from the Berwick axis in Cooper and also in several townships of Columbia county.

In No. 3 were seen *Rhychonella formosa*, *Atrypa reticularis*, *Favosites* sp? and many *crinoidal fragments.*

No. 5. *The Bossardville limestone*, is extensively quarried and burned here on the land of Mr. Derr. It makes an excellent lime for agricultural as well as building purposes.

The base of No. 5 carries the section to the extreme northern line of this township where the lower beds are concealed by soil and other débris.

Barometric elevations in Liberty.

	A. T.
Forks of road at A. Bogert's,	880'
" " 242 rods north of last,	675'
" " near William Madden's,	600'
Chillisquaque creek near G. Boyer's,	495'
Forks of road near Joseph Dean's,	580'
Cross-roads near J. Umpstead's,	515'
Forks of road near George Billmeyer's,	550'
" " next west,	560'
Chillisquaque creek near P. Billmeyer's,	485'
Forks of road near Daniel Muhl's,	570'
" " Joseph Middleton's,	570'
Cross-roads near John Shedden's,	505'
" " Thomas Perry's,	560'
Forks of road in Mooresburg,	675'
" " near Daniel Rote's,	600'
" " near Hugh McWilliams',	590'

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62. *Valley township.*

This lies east from Liberty, north of Mahoning, and west of Hemlock township. It is drained almost entirely by Mahoning creek southward.

The Montour anticline brings up the *Clinton beds* in Montour ridge, the crest of which forms the southern boundary of the township; while the *Lackawanna syncline* passes across the northern portion and holds a large part of the *Chemung beds* in its trough along the western half of the township, and toward the east the *Chemung-Catskill beds.* Its axis enters the township near its north-eastern corner, and passing westward goes near the cross-roads at Beyers' store.

The Clinton iron ore has long been very extensively mined in this township on the northern face of Montour ridge east from Mahoning creek. The *ore* comes to the surface half way up the mountain side, dipping 30°–35° N. 10°–15° W., and has been followed down by long slopes to a great depth.

The *ore* is used in the Danville furnaces, and a narrow guage R. R. carries it to the latter locality.

The Lower Helderberg limestone reappears at Mahoning

creek after disappearing near Little Fishing creek 10 miles east.

This limestone has long been quarried for the Danville furnaces on the land of Mr. A. F. Russell, about one mile north from the southern boundary of the township and near the west branch of Mahoning creek.

A. F. Russell's quarry, (*Fig. 86*; *page 294*.)

1.	*Stromatopora bed*,	10′
2.	Hard, blue limestone, fossiliferous,	25′
3.	"Bastard limestone,"	20′
4.	*Bossardville limestone*, bluish-black, in thin, shelly layers, non-fossiliferous, bluish-gray toward base,	70′
5.	Bluish-green beds containing small cavities from which the lime has been removed, and which are now lined with crystals of calcite,	10′
6.	Limy shales,	5′
7.	Hard, bluish-gray, magnesian lime,	20′
8.	Drab, limy shales,	8′
9.	Limestone, blue and shaly,	10′
10.	Buff and greenish-gray limy shales,	45′
11.	Bluish limestone, banded with thin blue and gray layers,	7′
12.	Limy shales, gray and greenish,	10′
13.	Bluish-gray limestone once quarried for the furnaces,	20′
14.	Buffish, limy shales,	10′
15.	Concealed,	20′
16.	Pale green, buff and bluish limestone,	25′
		310′

This section extends down into the *Salina beds* since the *Lower Helderberg* proper seems to end with No. 4; for there is a distinct change in lithology at this horizon, and all traces of fossils have disappeared. If the dividing line between the *Salina* and *Lower Helderberg* be placed at the base of No. 4, we shall have 125′ of *Lower Helderberg* in the section, and 185′ of beds belonging to the *Upper Salina*.

No. 1. *The Stromatopora bed*, still holds its place in the series, and is exposed at the top of the quarry, projecting in immense masses from the covering of clay and surface débris. The rock is bluish-gray and rather impure, but a perfect mass of *Stromatopora* and other *coral débris*, cemented into which are many fragments of shells.

No. 2 is rather pure limestone, containing many *crinoidal fragments*, together with *Atrypa reticularis*, *Rhynchonella formosa*, *Strophomena rugosa*, and many others.

No. 3. The "Bastard bed" re-appears here in a shape strikingly similar to that which it exhibits all through Columbia county, being a buffish-gray, impure, magnesian rock, often having a rotten appearance on its weathered surface.

No. 4. *The Bossardville limestone* furnishes the principal stone, being much purer and more constant in composition than any of the other strata. No fossils were observed in any of its layers at this locality, except some minute *Beyrichias*. It has the same dark blue, or almost black color, and thinly laminated character so often remarked elsewhere. The lowest 20′, however, is somewhat gray, and not so pure as the rest of it.

Nos. 5–16. The limestones in the *Upper Salina* exhibit various degrees of purity, one of them, like No. 13, having been used as flux for a long time until further digging revealed the purer *Bossardville beds*, above. They are nearly all more or less magnesian, and generally have a pale green, or buffish cast.

The dip is 25°–30° N. 10° W. at this locality.

A short distance west from Russell's quarry there is another operated by Mr. Philip Maus; a large quantity of limestone has been quarried from the *Bossardville beds* at this locality; but this stratum has now been mined out down to water level; and the great mass of "Bastard limestone," 30′ thick, makes a cliff along the back portion of the quarry, through which no one has attempted to cut after the *Stormville limestones* above, though the *Stromatopora bed* is seen in the summit of the hill above the quarry.

A short distance west from Maus' quarry, another has recently been opened up on the west bank of Mahoning creek by Mr. Bright. and there the following section was obtained:

Bright's quarry, (Fig. 87, page 294.)

1.	Massive limestone, bluish-gray fossiliferous,	25′
2.	Bastard limestone,	25′
3.	Bossardville limestone,	visible, 35′
		85′

Just east from this the *Stromatopora bed* makes a bold cliff along the stream and dip rapidly northward. It comes in just above No. 1 of section 87.

The lowest stratum has been reached by excavating a narrow cut through the Bastard bed and then working out a large basin in the bluish-black limestones below. Only 30′ of the *Bossardville limestone* are visible at this locality since the base has not yet been reached.

The limestones of No. 1 are not very pure, and it is doubtful if they could be used successfully as a flux in the iron furnaces.

West from this last point the *Lower Helderberg limestone* is buried under the débris which fills the wide valley and is seen no more until we come to the western boundary of the township where a quarry is opened just south from the Catawissa and Williamsport R. R. (Reading branch.)

The Hamilton shales are seen on Mahoning creek as far north as Mrs. Winterstein's where the *Chemung ridge* begins to rise.

Gray beds of shale, most probably in the *Marcellus*, crop out along the road at School-House No. 2, just west from East Mahoning creek. They dip N. 10° W. 30°.

Dark shales occur at the cross-roads near Mrs. Thomas', on West Mahoning creek, and they most probably belong in the *Marcellus*.

The *Chemung rocks* come down on West Mahoning near Mr. C. Fenstermacher's, dipping N. 10° W. 35°; and in passing northward up this stream the massive beds of the *Lower Chemung* dip under successively for three fourths of a mile. Here a concealed interval occurs, and no more exposures are visible until we come to the forks of the road near Mr. E. V. Flick's where *Chemung beds* dip S. 10° E. 20°–25°; the *Lackawanna synclinal axis* having been crossed about half way between Mr. Flick's and the forks of the road near Thos. Deyer's, 166 rods south.

On East Mahoning creek the *Chemung rocks* dip constantly northward from Mrs. Winterstein's to the northern line of the township where the bottom of the Lackawanna

syncline is reached and the *Chemung-Catskill beds* come in.

Barometric elevations in Valley.

	A. T.
Cross-roads near W. Purcell's,	585′
" " B. Wilson's,	560′
Crossing of Wilson's run west from last,	510′
Forks of road near E. Sidler's,	530′
" " T. Benfield's Est.,	550′
Mahoning creek near E. Sidler's,	525′
Forks next west at School-House No. 2,	565′
Forks of road near P. Baldy's,	520′
" next south from A. F. Russell's,	530′
Crossing of Mahoning creek near A. Dewitt's,	490′
Forks of road near Philip Roup's,	490′
" next north-west,	500′
" in Mausdale,	490′
R. R. crossing next north,	500′
Forks of road near T. Shepherdson's,	600′
" " Mrs. Jas. Curry's,	570′
Mahoning creek near Mrs. Snyder's,	495′
Cross-roads at Mrs. Thomas',	540′
Forks of road near Fenstermacher's tannery,	525′
" " Chas. Soper's,	905′
" " Roger Hendrick's,	805′
Mahoning creek at C. Fenstermacher's,	550′
Forks of road near Thos. Deyer's,	605′
Mahoning creek there,	595′
Forks of road near H. W. Beyer's,	700′
" " E. V. Flick's,	670′

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63. West Hemlock township.

This is a long, narrow, irregular area which extends north and south along the Columbia county line just east from Valley township. It is drained entirely by Mahoning creek, except a very small portion of its extreme north-west corner which drains northward into Chillisquaque creek.

The rocks of this township extend from the base of the *Catskill* down to the base of the *Clinton.* The former is caught in a narrow belt along the middle of the *Lackawanna syncline*, which crosses nearly through the center of the township, while the latter (*Clinton*) is brought up by the *Montour axis* into the summit of Montour ridge, the southern boundary of this area.

The Lower Helderberg limestone is concealed in this township. Its line of strike would pass near Mr. Obadiah Everitt's.

The Hamilton beds make a wide level valley across the southern portion, and are mostly concealed under a seemingly great thickness of débris.

The Chemung rocks make a steep high ridge as usual, overlooking the *Hamilton valley* just south from it and extend northward to the road which runs east and west past school-house No. 2, when the *Chemung-Catskill rocks* come down and color the soil with alternate beds of red and green. It is possible that all the *red beds* seen along the bottom of the *Lackawanna trough* belong to this *Transition series*, and that the *Catskill rocks* are not caught in it, but, however this may be, the belt of *red rocks* is about one half mile wide and then the *Chemung* comes up on a south dip and spreads over the northern portion of the township, seldom dipping at a greater angle than 30° and often only 20°.

The Hamilton beds come up a second time in the township at its extreme north-western corner, and make a broad valley to the north.

Barometric elevations in West Hemlock.

	A. T.
Forks of road near school-house No. 3,	650'
" " next west near W. Straub's,	635'
Cross-roads near C. T. Styer's,	995'
Forks of road 469 rods west of last,	615'
" " near W. William's,	640'
" " " V. Shultz's,	630'
" " " J. Shultz's,	670'
" " " W. Hawk's,	885'
" " just north from J. P. Shultz's,	635'
" " just north of last,	615'

64. Derry township.

This township lies north-west from the last one described and like it abuts against Columbia county on the east, while Valley township bounds it on the south. It is drained by Chillisquaque creek and its tributaries westward to the West Susquehanna in Northumberland county.

The Milton axis passes nearly through the center of Derry, and the dip north from it is so gentle that the *Hamilton beds* cover the surface over all the area north from its broad flat crest.

The Chemung rocks cover a narrow area along the southern margin, about two miles wide at the eastern border, but gradually narrowing to a point and finally passing south from the township line before reaching its western boundary. The northern line of this *Chemung outcrop* lies just south from the road which starts from J. K. Shultz's at the eastern line, and runs south-west past School-houses Nos. 3 and 4.

The Hamilton rocks which cover more than two thirds of this area have been eroded into a broad and almost level valley by Chillisquaque creek and its tributaries. This valley, which is two to three miles broad, does not rise much higher than 50′ above Chillisquaque creek at any point, and is nearly everywhere covered with a deposit of rounded bowlders of *Pocono sandstone* and other hard rocks. This seems to be the westward extension of the gravel and bowlder deposits which cover the *Hamilton low lands* in the township of Columbia county east from Derry.

The Lower Helderberg limestone comes up to the surface one mile east from Washingtonville, and has there been quarried a short distance north from Mud creek on the land of Mrs. Patterson, where 15′ of bluish flaggy limestone is visible dipping northward 6°–8°

A large quarry in this limestone is opened alongside the public road, near the Washingtonville Fair Grounds, on the land of Mr. Seidel, where the following is exposed:

Section at Seidel's limestone quarry, (Fig. 88, page 294.)

1. Soil,	4′
2. Limestone, dark blue,	15′
3. Dark brown sandy layers, quarried for building stone, (visible.)	5′

The rocks dip very gently northward at this point and it is impossible to determine at what horizon in the *Lower Helderberg* the quarry rock comes, since the surface débris conceals everything except the above section.

No. 2 seems to make a fairly good lime, and it very possibly belongs to the *Bossardville beds* since no fossils were observed in it.

No. 3 is quarried for building stone. It comes in layers 4″–6″ thick and is divided into rectangular blocks by two systems of joints.

The Oriskany cherty sandstone occurs in fragments on the surface at the crossing of Chillisquaque creek near its junction with Mud creek. It is quite probable that the parent bed lies directly beneath the surface here.

Just west from Trinity Reformed church *Hamilton dark shales* make a steep bluff 35′ high, the top having an elevation of 565′ A. T.

Barometric elevations in Derry.

	A. T.
Forks of road near J. Pegg's,	545′
Level of Mud creek next north-west,	510′
Cross-roads at Trinity church,	565′
Forks of road 87 rods north-east,	550′
Chillisquaque creek next north-west,	525′
Cross-roads at Washingtonville Fair Grounds,	550′
Washingtonville,	525′
Chillisquaque creek at junction with Mud,	500′
Forks of road near G. B. Gresh's,	530′
" " near J. Wagner's,	580′
" " next north,	610′
" " near P. Carr's,	510′
Crossing of run near Daniel Frazier's,	520′
Forks of road near B. Gerringer's,	550′
" " " A. St. Clair's,	550′
" " " W. Switzer's,	565′
" " " P. Evart's,	900′
" " 203 rods north of last,	700′
Crossing of run next north,	660′
" " "	620′
Cross-roads next north, (near H. Cooper's,)	575′
" near J. Butler's,	600′
Run at Alex. Billmeyer's,	525′
Chillisquaque creek next north,	500′

65. Limestone township.

This area lies west from Derry, and has Northumberland county for its western boundary. It has the shape of a

triangle with the long narrow apex pointing northward. The northern and eastern portions are drained by Chillisquaque creek and its tributaries, while a small area along its western portion drains westward through Warrior creek.

The *Milton* and its *sub-axis* pass through the southern portion of the township and bring up the *Lower Helderberg* and *Salina rocks* in a broad crumpled arch, north from which the *Hamilton beds* spread to its northern point.

The southern line of this area runs along the crest of *Limestone ridge*, a high sharp elevation made by the outcrop of the *Oriskany sandstone* and the underlying, massive members of the *Lower Helderberg limestone*, the former making its long southward slope, while the latter makes its crest and abrupt, almost precipitous northern slope.

The Milton axis passes just north from the crest of this ridge, since about one fourth mile north from the southern line of the township, the rocks dip 20° N. 10°–15° W., while along the ridge they dip southward at the same rate.

The Watsontown sub-axis crosses this township about one mile and three fourths north from the *Milton axis* and as the syncline between the two is shallow and somewhat crumpled with minor folds itself, the highest beds found in the intermediate area belong to the *Oriskany sandstone*.

Erosion has exposed the underlying *Lower Helderberg limestone* at many points within this belt of nearly two miles between the crest of the two axes.

This limestone (L. H.) has been extensively quarried at several localities along the northern slope of Limestone ridge, and one of these is on the land of Mr. Jno. W. Caldwell at the extreme southern line of the township, where a small stream cuts southward through the ridge to Chillisquaque creek. The lower portion of the *Bossardville beds* has there been quarried and burned into lime for agricultural and other purposes.

J. Mauser has a quarry in these same beds about one half mile east from Mr. Caldwell's.

Extensive quarries on the upper portion of the *Bossardville beds*, and a portion of the *Stormville limestones* are operated on the land of Edward Baldy, one mile and a

quarter east from Caldwell's. The quarries are near the forks of the road 70 rods west from Mr. Baldy's, and there the rocks dip N. 10°–15° W. 20°, thus showing that the *Milton axis* passes south from the locality of the quarries.

The Stormville shale is brought down by the northward dip, and makes the valley in which the small stream flows eastward near Mr. Baldy's. It is mostly a blackish, sandy shale, and appears to be 75′–100′ thick.

The Oriskany beds come down just north from the valley of *Stormville shale* and make a high ridge, extending east and west for more than a mile. The surface is here covered with small blocks (4″–8″ in diameter) of dirty yellow sandstone, many of which are somewhat cherty and fossiliferous.

The *L. H. limestone* has been quarried and burned on the land of Mr. M. Wagner, one mile north from Mr. Baldy's, where the top layers have been exposed by erosion. This limestone also crops out along the road one half mile north from Mr. Wagner's, and just north from this it dips slowly northward, thus showing that an *axis* crosses the measures near this point.

The Oriskany sandstone then comes down and makes a long, gentle slope toward the north-east in the vicinity of Mr. Jno. Shearer's, covering the surface with its small, rectangular blocks. It also makes the same kind of a slope toward the north in the vicinity of Mr. C. Boyer's, dipping under the *Hamilton* plain near L. Schuyler's.

In passing south from Mr. Boyer's, the rocks rise gradually (8°–10°) toward the crest of the *axis*, and the *L. H. limestone* finally comes up in the vicinity of Mr. G. B. Runyan's, from which point it continues along the road to D. F. Gonger's where the *axis* appears to cross.

This axis enters the township from Northumberland county near the cross-roads at S. Glaze's where it brings up the *Salina beds* into the summits of the hills, and these rocks occur along the road southward to J. K. Shell's and beyond.

The Lower Helderberg limestone has been quarried to a considerable extent along the north slope of *Limestone*

ridge just south from the village of Limestoneville, on the land of Messrs. Cotner, Davis, and others.

The Bossardville beds are the ones generally operated on, since they are purest and most accessible.

Barometric elevations in Limestone.

	A. T.
Forks of road near Jno. W. Caldwell's,	580′
" " Peter Baldy's,	580′
" 395 rods east from last,	680′
" near Ed. Baldy's,	650′
" " School-House No. 4,	770′
" " Michael Wagner's,	730′
" 186 rods next north,	720′
Cross-roads near Jno. Shearer's,	675′
Forks of road near S. Aldridge's,	585′
" 58 rods west of last,	630′
" near C. Boyer's,	580′
" " G. B. Runyan's,	675′
" " D. F. Gonger's,	700′
" " Sarah Oakes',	640′
" south from Jno. F. Derr's,	650′
Cross-roads 111 rods west of last,	610′
" 138 rods south of last,	625′
Forks of road near J. K. Shell's,	600′
" " Thomas Smith's,	575′
" " Limestoneville,	550′
" just south from C. Cotner's,	585′

66. *Anthony township.*

This township occupies the extreme northern point of Montour, having Columbia county on the east, Northumberland on the west, and Lycoming for its northern boundary. It is drained entirely by Chillisquaque creek and its tributaries.

The only rocks appearing above drainage level are the *Hamilton* and *Chemung.* The former covers the entire southern half, occupying about two thirds of the surface of the township, the latter being confined to a strip 1½–2 miles wide along the northern border.

The *Hamilton* area has been so eroded by Chillisquaque creek and its tributaries that no portion of it rises to an elevation of more than 700′–750′ A. T., hence on looking

down on it from the *Chemung highlands* at the north it resembles a broad valley through which a great stream may once have flowed, and such indeed seems really to have been the condition of affairs during the valley's history, for covering its highest summits we now find vast heaps of rounded *Pocono*, *Catskill*, and other bowlders, together with much sand and fine trash.

The strata all dip northward, but so gently that the *Hamilton beds* cover a belt more than four miles broad. It is possible that some minor folds or wrinkles run through this area spreading these beds over a wider belt than usual. They are covered up and concealed over a large part of this area by the bowlder deposits, but wherever revealed in the cuttings of roads and streams, as at White Hall and other places, they dip slowly northward.

The Chemung rocks found along the northern portion of this township rise in a steep slope to an elevation of 1200′ A. T., or nearly 600′ above the Hamilton area, and stretch northward in a series of undulating ridges and peaks far into Lycoming county.

No rounded or transported bowlders of any kind were seen on these *Chemung uplands*, though, owing to the steepness of the slopes which lead up to them, the exact limit of the *bowlder deposits* found on the *Hamilton* area could not be determined, since they seem to have been generally shed by erosion from the Chemung slopes where they may formerly have existed. The highest elevation on which these bowlders were found in this township was 750′ A. T., but it is very probable that they extended higher since in Northumberland county, west from this, they go up to 800′ A. T.

The *Chemung* of this township belongs to the lower half of that formation, and is consequently rather barren in fossils as only a few fragments of *Spirifers* were seen in driving over several hundred feet of these beds.

Barometric elevations in Anthony.

	A. T.
Forks of road near F. Brown's at the southern line of the township, ...	585′

Run at crossing near Charles Mowry's,	525′
Forks of road near John Dye's,	575′
Cross-roads at David Smith's,	595′
Forks of road 102 rods north of last,	600′
Cross-roads at Exchange P. O.,	575′
Forks of road near John Caldwell's,	600′
" " " Robert Caldwell's,	590′
" " " D. Derr's,	590′
" " " Henry Orner's,	575′
" " at Comly P. O.,	595′
" " 45 rods north of last,	600′
Creek crossing here,	590′
Forks of road near Andy Snyder's,	630′
" " " J. Walzie's,	665′
Chillisquaque creek here,	660′
Forks of road near George Kisner's,	740′
" " " Henry Gearhart's,	1040′
Chillisquaque creek at George Kisner's,	690′
Forks of road south from Jacob Albech's,	1155′
" " near Jackson McKee's,	1200′
Creek crossing south-east from Louis Seybold's,	640′
Forks of road near School-house No. 4,	735′
" " " Mrs. J. Clark's,	690′
" " " Bethel church,	755′
" " in White Hall,	710′

Chapter XI.

Township geology of Northumberland county.

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67. *Lewis township.*

This is a long narrow area occupying the north-eastern corner of Northumberland county, having Montour on the east and Lycoming on the north. Its western and central portions drain westward through Warrior creek to the West Susquehanna river, while the eastern portion drains into the same river by way of Chillisquaque creek.

The *Watsontown axis* dies out eastward in the southernmost part of this township and brings up the *Salina beds* over all that part of it, while to the north the *Lower Helderberg*, *Oriskany*, *Hamilton*, and *Chemung* dip north successively, the latter covering the most northern portion.

The upper half only of the *Salina beds* comes to the surface in this township, and hence the *Bloomsburg red shale* nowhere appears; but the pale green, impure magnesian limestone, calcareous shales, and interstratified red beds of the *Upper* and *Middle Salina* occupy the south-western corner of Lewis, and are frequently seen cropping out along the roads.

The Lower Helderberg limestone makes an irregular line of outcrop across the township, entering it from Montour county near the south-east corner and passing north-westward just south from Turbutville.

This limestone is frequently seen along the road which leads north past D. B. Montgomery's and Peter Menges; and one half mile north from the latter is quarried and burned on the land of Dr. Treon, where 30′ of dark shelly limestone are seen containing many thin streaks of calcite.

This very probably represents the *Bossardville beds*. The layers dip northward 20°.

A massive bed of gray, fossiliferous limestone occurs at the roadside 70 rods north from the quarry, and this would seem to be the top of the *Lower Helderberg*, since just north from it we see the dark shales of the *Stormville beds*. If the dip were constant between the quarry and this upper fossiliferous bed, it would indicate a thickness of nearly 400′ for the *Lower Helderberg*, but as it is quite variable in this region, being frequently reversed for short distances, no dependence can be placed on the seeming thickness since it is probably not more than half of 400′.

The Marcellus black slates are seen along the road just north from the village of Turbutville as we descend the road toward Turbutville cemetery.

Hamilton shales of dark brown color and nearly horizontal occur at the forks of the road near Thomas Russell's.

The Chemung beds begin about one mile north from Mr. Russell's, and rising in hills 500′–600′ above the Hamilton valley, extend northward in an undulating plateau far into Lycoming county. They cover a belt about two miles broad along the northern border of this township.

The entire area, south from this *Chemung plateau*, gives evidence of submersion, most probably during the *Flooded river epoch*, for everywhere we find a thick deposit of transported bowlders and other trash which must have been carried by running water in some manner since no evidence of *Glacial transportation* could be found. These bowlders consist largely of *Pocono* and *Catskill sandstones*, with a frequent admixture of local rock, the most of the former rounded, but angular ones being occasionally seen. They usually rest in an admixture of clay, sand, and muddy trash, and may possibly have been dropped from floating ice which, breaking off from the terminus of the north-eastern glacier, carried the material of the *Terminal moraine* over the areas submerged by the subsidence of the *Flooded river epoch*. They occur on the summits of the highest hills (about 700′ A. T.) all over the *Hamilton*, *Lower Helderberg*, and *Salina valleys*. The exact upper limit of their

distribution was not determined in this township, though they are not found on the *Chemung hills* which range an elevation from 900′-1200′ A. T.

Barometric elevations in Lewis.

	A. T.
Forks of road near Wm. Dean's,	645′
Muddy creek near D. B. Montgomery's,	550′
Forks of road next north at School-House,	575′
" " 125 rods north of last,	565′
" " next north of Dr. Treon's,	550′
" " 68 rods north of last,	570′
" " next north, near south line of Turbutville,	600′
Main street in Turbutville,	600′
Forks of road at Turbutville cemetery,	560′
Warrior creek near J. Holyoke's,	550′
Forks of road near Mrs. Lowe's,	620′
Forks of road just south from Thos. Russell's,	585′
Creek level near W. Russell's,	575′
Forks of road next west,	610′
Creek near J. Stall's,	540′
Forks of road near J. Deutler's,	600′

68. Delaware township.

This lies directly west from Lewis, having Lycoming county for its northern boundary, and extending westward to the Susquehanna river (West Branch) which separates this township from Union county.

The rocks of this area extend from the lower half of the *Chemung* found along the extreme northern portion down nearly to the base of the *Salina* along the southern margin.

Transported bowlders are quite prominent in this township, and their upper limit was determined at about 800′ A. T. at least none were found above the horizon along the Chemung hills which border the *Hamilton valley* at the north and rise 300′-400′ above the same.

The Hamilton bottom rocks set in near M. Metzgar's at the eastern line, N.W. of Turbutville, and trending westward follow closely the valley of Delaware creek until the latter meets its north branch near J. Graven's, when it veers north-westward into the Susquehanna valley. North from

this line the *Hamilton beds* stretch out in a broad valley 1½–2 miles wide, the northern margin of which extends from near Jos. Witman's on Warrior creek, in a direction somewhat north of west until we come to the Susquehanna valley when it veers around to the north and extends to the northern line of the township.

No point of this *Hamilton area* seems to have risen high enough to escape submersion beneath the waters of the *Flooded river epoch*, for rounded bowlders of *Pocono*, *Catskill* and other rocks, together with beds of gravel, clay, and sand, are found all over its belt.

Where the *Hamilton valley* first debouches into the West Susquehanna, near the northern line of the township, a vast deposit of water-worn bowlders, gravel, and other trash is found bordering the eastern bank of the river in a broad terrace, or rather series of terraces whose summits come at the following elevations above the Susquehanna, and above tide:

		A. T.
Top of 3d terrace above river,	175′	635′
Top of 2d " "	40′	500′
Top of 1st " "	20′	480′

The first one is a narrow shelf along the channel and is evidently the flood plain of the present stream, since it is composed of fine sand, small gravel, mud, &c.

The 2d terrace is covered with sand and coarser gravel, some of the pebbles being two inches or more in diameter. It rises abruptly from the inner margin of the 1st and extends back eastward in a nearly level plain one fourth mile from the river.

The 3d terrace rises with an almost precipitous escarpment from the summit of the 2d to a height of 135′ above the same, or 175′ above the river, and 635′ A. T. It is a mere mass of bowlders, many of which are 2½′–3′ in diameter, some angular, but most of them more or less waterworn. The immediate riverward face of this terrace is only 625′ A. T., but it spreads eastward in a gently rising plain until it attains to 635′ A. T.

In passing southward from the cross-roads near W. Transit's this terrace runs along the river at about the same ele-

vation, keeping its steep escarpment facing the stream until we come to near D. Young's, about one mile south from the northern margin of the terrace, when it begins to fall away gradually, and when we come to the forks of the road at Mrs. McKane's, its elevation is only 545′ A. T. or nearly 100′ lower than it is one mile and a half north.

This vast deposit of *Pocono*, *Catskill*, *Chemung*, and *Hamilton* débris piled up in a broad terrace along the Susquehanna just where it emerges from the *Chemung highlands* would seem to have but one explanation, viz: the material has been dropped in the eddy formed at the junction of the Susquehanna with a great river flowing westward along the Hamilton valley during the *Flooded river epoch.*

The Lower Helderberg limestone sinks below Delaware run on a northward dip just south from Mr. J. Graven's. Its uppermost beds are there exposed, however, and have been quarried for lime by Mr. Graven.

The same *Lower Helderberg beds* cross the Philadelphia & Erie R. R. at J. Nicely's, where they have also been quarried and burned into lime.

In passing southward from Delaware run past J. Graven's the surface rapidly rises into a rather broad ridge, which is made by the *Oriskany cherty sandstone*, small blocks of which containing *Spirifera arenosa* are scattered over the surface. The *Oriskany* forms the surface rock until we come to the cross-roads near J. Seibert's when the *Stormville blackish shales* come up and are exposed along the road just south from Mr. Seibert's.

The Lower Helderberg limestone outcrop comes to the surface southward from the last locality under a deep covering of bowlders and surface débris, so that it passes into the air unobserved. The line of its basal outcrop is just north from the east and west road which runs from the mouth of Delaware run to the Warrior Run Presbyterian church, at the eastern line of the township.

The pale green limy shales of the *Upper Salina* are seen along this road at Mr. S. Smith's, dipping northward at the rate of 15°–20°.

In passing south from S. Smith's, the surface is covered with rounded Pocono bowlders up to the summit of the hills at 690′ A. T.

The red beds of the Upper Salina come up near Robert McKee's, and crop out along the road for some distance south.

The Watsontown axis crosses the rocks at J. Cathart's just east from Watsontown (the village from which the axis was named), for in passing south from there the *Lower* (*Bloomsburg*) *Salina red beds* dip southward at the rate of 30°–40°, and this brings down the variegated shales and limestones of the *Middle Salina* before reaching Warrior run. This is the axis which just west from Watsontown in Union county elevates the sandstones of No. IV into a high mountain.

The river terraces in the vicinity of Watsontown are covered with a thick deposit of sand up to 100′ above low water, or at least it was seen at this elevation, and it probably goes higher.

The rapid southward dip seen in the vicinity of Watsontown continues for only about one half mile south from the Watsontown axis when it flattens out and is even reversed near the southern line of the township since the *Lower Helderberg limestones* are not brought down, the highest beds seen on the surface being the pale green limestones of the *Upper Salina.*

Barometric elevations in Delaware.

Forks of road at J. Dentler's,	625′
" 357 rods north of last,	750′
" near J. Crawford's,	685′
" 96 rods north,	800′
Elevation of Chemung ridge just north,	1100′
Forks of road near Wm. Marshall's,	690′
" " Wm. Storner's,	575′
Cross-roads near L. Buchner's,	520′
Forks of road near R. Algert's,	550′
Cross-roads just south-east from J. Oysler's,	640′
" 136 rods north-west,	575′
Forks of road 70 rods north-west of last,	495′
" near Wm. Taylor's,	480′
Cross-roads near Wm. Transit's,	575′

Forks of road near D. Young's,	635'
" " G. Stoler's,	590'
" " Rev. D. H. Hull's,	545'
" " G. Staufer's,	540'
" next east from last,	530'
Cross-roads at J. Seibert's,	575'
" 159 rods south,	525'
" near C. Ravert's,	525'
" " S. Smith's,	580'
Forks of road near Robert McKee's,	580'
" 113 rods south,	635'

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69. Turbut township.

This lies directly south from Delaware and Lewis, extending from the Susquehanna river on the west to the Montour line on the east. It is drained by Limestone and Muddy runs—streams which take their rise in the eastern portion of the township and flow westward to the West Susquehanna.

The Milton axis, designated from the town of that name near the south-western corner of this township, passes across the southern portion and brings up the *Oriskany sandstone* and underlying massive *Lower Helderberg limestones* into a prominent elevation known as Limestone ridge, the crest of which makes the southern boundary of the township. It is the westward extension of the Limestone ridge of Montour county which begins at Chillisquaque creek near Washingtonville and runs westward to the Susquehanna river just below Milton.

The Milton axis carries the *Middle Salina* variegated beds, and brings up the *Bloomsburg red shale* of the *Lower Salina*, in a semi-ellipse, as shown by the red belt upon the map.

The *Milton* and *Watsontown axes* are separated by a space of four miles at the Susquehanna river. The intervening basin is crumpled into small folds, two of which are of nearly as much importance as the *Watsontown* and *Milton axes* themselves.

The northern (*Sub-Watsontown*) *axis* passes between

McEwensville and Preslertown; and dies away eastward of these villages.

The southern (Sub-Milton) axis runs along just south of the Delaware township line, and dies out eastward along the Lewis township line.

In the cuts of the Phila. and Erie R. R. between Milton and the northern line of Turbut the *Bloomsburg red shale* or *Lower Salina* is frequently exposed, being thrown into nearly a dozen closely appressed folds like the plaits of a fan.

The Lower Helderberg limestones make the summit of Limestone ridge which rises to an elevation of 650′–700′ A. T. It is the massive upper portion or *Stormville limestone* which makes the crest of the ridge while the *Oriskany cherty sandstone* makes the southern slope in Chillisquaque township, and the *Bossardville limestone* makes the steep northern slope in Turbut.

This last limestone has been quarried and burned at several localities along the northern slope of Limestone ridge by Messrs. Mosteller, Funk, and others, but it seems to be thinner and not so pure as in other townships.

The Middle Salina variegated beds are visible on nearly every road in the district, and sometimes they contain beds of rather pure blue limestone as seen at the roadside on Muddy run near E. Shaffer's. Some of these *Salina limestone beds* are pure enough to burn into lime.

Barometric elevations in Turbut.

	A. T.
Forks of road east from W. Weidenhammer's,	500′
" " near T. Crawford's,	510′
Limestone run just south of last,	475′
Forks of road near J. Mosteller's,	480′
Summit of Limestone ridge on road extending south from last,	650′
Forks of road near H. Funk's,	550′
" " 46 rods west from last,	550′
Limestone run next north last,	490′
Cross-roads near G. W. Funk's,	490′
Forks of road next north of last,	610′
" " 108 rods east from last,	525′
" " 281 rods next north,	535′
" " next north,	510′
Muddy run at J. Dunkle's,	475′

Forks of road near E. Shaffer's,	685′
" " C. Follmer's,	500′
" " S. Klapp's,	555′
" west from J. Kurtz's,	575′
" near E. Eschbach's,	575′
" " D. Eschbach's,	555′
" " Wm. Dean's,	620′

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70. Chillisquaque township.

This lies south of Turbut, in the narrowest part of Northumberland county; it is only about 3 miles from the south-western corner of Montour to the Susquehanna river.

Chillisquaque creek flows from near the north-east corner of the township south-westward through it to the river at its south-west corner.

The Montour axis brings up the *Clinton beds* on *Montour ridge* along the southern line; while the *Milton axis* elevates the *Oriskany* and *Lower Helderberg beds* into a ridge along the northern line; the township therefore occupies the western extension of the Lackawanna syncline.

The surface-slopes on either side of Montour ridge are covered with fragments of a yellowish-gray sandstone and sandy slate which have very probably come from the *Clinton lower olive beds* which crop out along the summit of the ridge on the crest of the arch.

The Clinton fossil ore has never been seen in this township, most probably because where it would come to the surface (along the foot slope of Montour ridge) is covered up with débris.

The Bloomsburg red shale, or the *Lower Salina*, is seen making a low ridge parallel with the road which runs east from Mr. Jos. Pardee's just north from Chillisquaque creek.

The Lower Helderberg limestone comes down about one half mile north from the *red shale* ridge, and crops out along the road which runs east and west through Montandon and Sodom. It has been quarried to a considerable extent on the land of Mr. Troxell, about one mile east from Montandon where the following section was observed:

Mr. Troxell's quarry, (*Fig. 89, page 294.*)

1.	"Bastard limestone,"	visible 10'
2.	Dark gray limestone,	10'
3.	Dark blue limestone,	3'
4.	Blackish blue limestone,	30'
5.	Blue shaly limestone in thin layers,	5'
		58'

Nos. 2-4 are the quarry portions and they are doubtless a part of the *Bossardville limestone*, since they agree in physical characteristics with that stratum as exhibited in Montour and Columbia counties. These limestones make a ridge just north from the road.

The same bluish black *Bossardville limestone* has been quarried a short distance east from Mr. Troxell's and near the school-house, just south from the road; and its line of strike keeps it south of the east and west road on to the eastern line of the township.

The Stromatopora bed is exposed at the roadside near Mrs. Yount's, about one half mile east from the limestone quarry at the school-house. It is a perfect mass of *Stromatopora concentrica* and other *fossil corals*.

A quarry was once operated in the top of the *Lower Helderberg limestone* on the land of Mrs. Yount just south from the road.

The Hamilton rocks occupy a belt about two miles wide across the central portion of this township, and are quite well exposed in the vicinity of Fitzer's school-house and the Ev. Church, where dark brown shales crop out along the road.

The contact of the *Oriskany sandstone* and the overlying beds of *No. VIII* is seen in a cut on the Reading R. R. about 300 yards east from its Milton switch. There resting on the *chert beds* of the Oriskany we see 10'-15' of grayish white sandy shale, which may possibly be a portion of the *Cauda galli grit*.

The Oriskany sandstone makes the long south slope of Limestone ridge at the northern line of this township, and its débris is scattered over the surface along the road which runs east and west at the foot of the ridge.

The Marcellus black shale is exposed at the cross-roads near William C. Lawson's, and its outcrop runs eastward from here 200–300 yards south from the road.

At the cross-roads near Mrs. Cowley's the cherty *Oriskany sandstone* crops out at the roadside.

Barometric elevations in Chillisquaque.

	A. T.
Cross-roads near William C. Lawson's, ...	535′
Summit of Limestone ridge next north, ...	650′
Forks of road 156 rods east from Lawson's, ...	550′
Cross-roads near Mrs. Cowley's, ...	585′
Summit of Limestone ridge just north, ...	635′

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71. Point township.

This township lies next south from Chillisquaque between the two branches of the Susquehanna river, and extends in a long point eastward between the river and the Montour county line.

The Montour axis elevates the *Clinton rocks* into Montour ridge (1000′-1200′ A. T.,) the crest of which makes the county line.

The rocks all dip south 40°–45° to the most southern point of the township at Northumberland, at the axis of the *Northumberland syncline*, which here holds a few hundred feet of the *Catskill beds*.

Fragments of a hard, yellowish-gray sandstone are scattered over the surface all along the southern slopes of Montour ridge and even over the *Chemung hills* to the south. They have come from the *Clinton lower olive beds* at the summit of Montour ridge.

There is some mystery connected with the transportation of these bowlders, all of which are angular, and not waterworn. Bowlders of yellowish-gray sandstone, *Iron sandstone* and other of the *Clinton beds* occur on the summits of the Chemung hills at 800′ A. T. while a broad valley 200′–300′ lower separates these hills from the source of the bowlders on Montour ridge. No evidence of *Glacial action* is to be seen.

Terraces occur at Northumberland and are well marked along the West Susquehanna, the succession being as follows:

4th	Terrace	above	Susquehanna	river,	175′	A. T.	605′
3rd	"	"	"	"	80′	"	510′
2nd	"	"	"	"	55′	"	485′
1st	"	"	"	"	25′	"	455′

The 1st terrace is the present flood-plain of the Susquehanna. *The 2d* rises abruptly from the 1st and is not very wide. But the *3d* is nearly one fourth mile broad and with a gentle slope from the center toward the river escarpment. Only a narrow shelf of the *4th* has been left by erosion, and it is possible that its top should be placed a few feet higher.

A bowlder of Gneiss (1′ in diameter) was seen on the riverward slope of this highest terrace.

The Chemung-Catskill rocks underlie a considerable portion of the borough of Northumberland; but as we go north from it, the lowest of these red beds come up on the Phil. & E. R. R. near G. B. Mertz's; and then the *Chemung rocks* crop out occasionally until Gulich's School-House is reached, where the *Hamilton beds* begin to rise into the air dipping S. 10° E. about 40°.

The Lower Helderberg limestone crosses the Phil. & E. R. R. just south from the forks of the road near Mr. McWilliam's, 2¼ miles N. of Northumberland. Its outcrop is concealed on the R. R. but just east from that it is exposed in a field, where 30′ of bluish-gray limestone are visible in an *old quarry* that has long since been abandoned. The portion of the series operated on comes at the horizon of the *Stromatopora bed*, and the limestones are, therefore, quite impure; dip S. 10° E. 45°.

On the opposite side of the river in Union county this limestone makes a high bluff and is extensively quarried for flux at the Lewisburg furnace near by.

The Lower Helderberg limestone is also extensively quarried by Mr. Rohrabaugh, about one mile and a quarter east from the West Susquehanna near the road leading east from McWilliams'. A switch has been constructed to the quarry from the Phil. & E. R. R., and a considerable quan-

tity of limestone is shipped to iron furnaces in the Susquehanna valley. The following section was made at this quarry:

Rohrabaugh's quarry (Fig. 90, page 294.)

1.	Impure limestone, dull gray, (*Bastard limestone,*) . . .	15′
2.	Gray limestone, shaly, ...	25′
3.	Bluish-gray, massive limestone, ...	12′
4.	Bluish-black limestone, ...	25′
5.	Gray, thinly laminated, shaly limestone, ... visible	30′
		107′

It seems probable from the structure of the section here that No. 1 is identical with the "Bastard limestone" of Columbia and Montour counties, and that Nos. 2–5 represent the *Bossardville beds.*

About one half mile further east is another small quarry on the land of Mr. Snyder, where the bluish-black portion of the *Bossardville beds* has been burned for agricultural purposes.

The Oriskany cherty sandstone makes a low ridge just south from the outcrop of the *Lower Helderberg limestone,* and its small hard bowlders occur in many localities from the river eastward.

Watson's school-house, two miles and a quarter east from the West Susquehanna, is situated on a bluff of this *Oriskany chert* from which a steep escarpment of *Lower H. limestone* descends into a valley to the north nowhere above 620′ A. T.

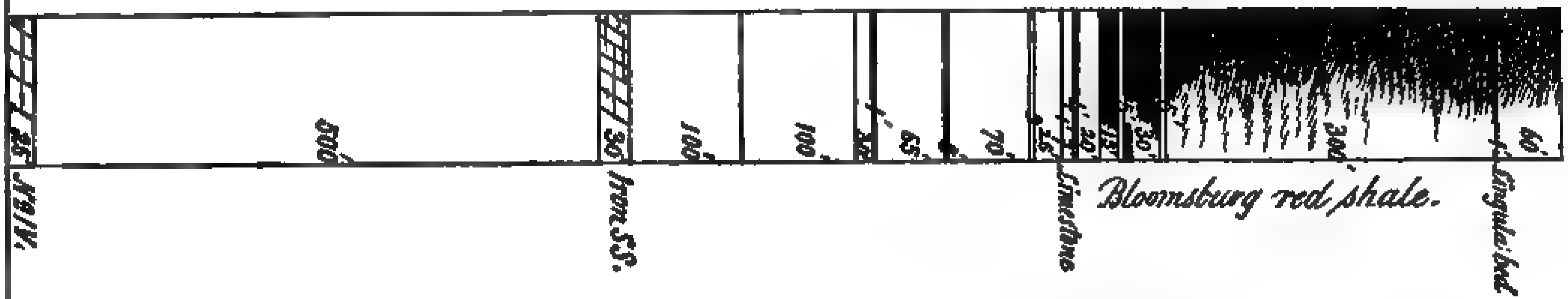
Sink holes.—Bowl-shaped depressions are found along the strike of the *Lower Helderberg limestone* in this region, made by the surface caving into underground caverns. One of these "Sinks" occurs just north from the school-house mentioned; it is about 50′ across at top, 35′ deep, and almost perfectly funnel-shaped.

The L. H. limestone has been quarried just north from Watson's school-house, where some rough-looking, dark gray limestone is visible dipping S. 10° E. 40°.

The Fossil ore is mined on the southern slope of Montour ridge about 225 rods north from the road that runs

PL. XXVI.

Fig. 91. Section at Chulasky-furnace, in Point township, Northumberland county, Pa.



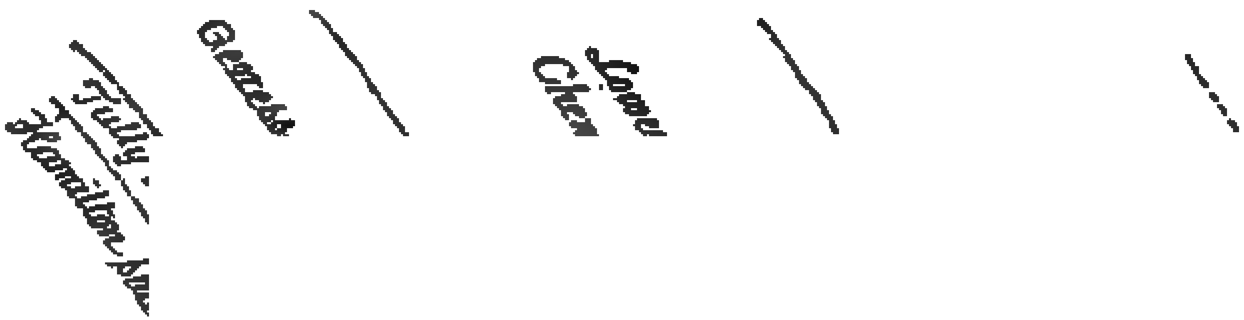


Fig. 94. (page 351.) Section along the river bluffs above South Danville.

G. 7.

east and west through the central portion of this township. It has been opened at only one locality, viz: on the land of Mr. J. Knauss, but it doubtless exists under the deep covering of débris nearly everywhere along the southern slope of Montour ridge through this township, though it is possibly too thin for profitable mining at some localities. It is only 10″–12″ thick at Knaus'.

Johnson's run cuts southward through the *Chemung ridge*, and drains the central portion of this township into the North Susquehanna. Its course through the *Chemung rocks* is quite gorge-like, and much of it looks like a comparatively recent cut, as no transported bowlders were seen along its valley.

The transition VIII–IX rocks come into the section near the mouth of Johnson's run, and on the south shore of the North Susquehanna the genuine *Catskill beds* occur.

Two broad *terraces* are seen along the North Susquehanna river in many localities, one at 455′ A. T. and the other at 485′. Both are covered with sand and transported bowlders.

Among these I noticed some very large ones (4′–5′ in diameter) of the *Pottsville conglomerate*.

These terraces seem to be continuous with the 1st and 2d seen along the West Susquehanna at Northumberland.

The Tully limestone is exposed in a cut along the D. L. & W. R. R. near Reed's school-house, about 3½ miles above Northumberland, where it contains the following fossils:

Dalmanites colliteles, *Calymene rana*, *Atrypa reticularis*, *Strophomena rhomboidalis*, many *Crinoidal remains*, and a species of *Zaphrentis*.

Here the *Chemung ridge* disappears, since the strike (S. 80° W. or N. 80° E.) carries those beds obliquely across the North Susquehanna river, at Reed's school-house; and they have of course been eroded; so that, as we pass up the river, a wide level valley of *Hamilton*, *Lower Helderberg*, and *Salina rocks* extends northward nearly a mile from the river bank back to the southern foot of Montour ridge.

This valley, 485′ A. T. and covered with sand and transported bowlders, representing the *2nd terrace* at Northumberland.

The *Hamilton*, *Oriskany*, *Lower Helderberg*, and nearly all of the *Salina* beds pass out of this township to the opposite side of the Susquehanna river as we ascend the stream to Chulasky furnace; but they do so unperceived, as the terrace deposits cover up everything.

Just above Chulasky, however, the river washes its northern shore, and has removed all of the terrace deposits from the steep slope of Montour ridge, for a considerable distance along the D. L. & W. R. R., leaving the steeply-dipping rocks finely exposed in the cuts of the R. R. and the country road just north from the latter.

Passing up the D. L. & W. R. R. from Chulasky furnace the following section was constructed:

Chulasky Furnace Section, (Fig. 91, page 338.)

1.	*Red shale*, blotched with pale green,	Bloomsburg red shale.	60′
2.	Variegated (red and green) shale containing a species of *Lingula* in large numbers,		1′
3.	Red shale, a few thin streaks of green,		300′
4.	Greenish limy shales,		5′
5.	Red shales,		30′
6.	Green shales,		5′
7.	Red shales,		15′
8.	Bluish-green shales,		20′
9.	Red shale,		4′
10.	Bluish-gray shales,		7′
11.	*Limestone*, containing many fossils,		1′
12.	Bluish-gray limy beds,		25′
13.	Concealed,		5′
14.	Bluish, shaly, limy beds, fossiliferous,		70′
15.	Hard, blue limestone,		5′
16.	Limy shales and thin limestones,		55′
17.	Limestone, very fossiliferous,		1′
18.	Blue, shaly limestone, fossiliferous,		30′
19.	Bluish-gray, limy beds, sparingly fossiliferous,		100′
20.	Concealed and olive shales,		100′
21.	*Iron sandstone*,	visible	30′
22.	Olive Clinton lower shales fossiliferous near middle, (about)		500′
23.	Greenish-gray and reddish massive hard conglomerate, supposed to belong to the top of the Medina sandstone, visible to bottom of exposure,		25′

No. 1 to 9. Taking No. 9 as the base of the *Bloomsburg red shale* or *Lower Salina* the section may be summarized as follows:

Bloomsburg red shale Nos. 1-9 inclusive, ...		416'
Clinton upper shales including the series usually holding the *fossil ore*, (which seems to be absent here,) Nos. 10-20 inclusive, ...	423'	953'
Iron sandstone, ...	30'	
Clinton Lower olive slates, ...	500'	
Medina? sandstone, ...	25'	
Total, ...		1294'

The *Clinton fossil ore* is completely absent from this section; though the very fossiliferous limestone, No. 17, most probably represents the stratum which is so often *ore bearing* in the *Clinton* of this region; since the fossils usually found so abundant in connection with the *fossil ore* occur in this stratum, viz: *Strophomena depressa*, *S. alternata*, *Atrypa reticularis*, *Rhynchonella robusta* and other forms.

These species, however, are quite abundant at several horizons in the interval from No. 10 to 20 in the section.

There are impure limestones and limy shales throughout this entire interval of 423', and it is possible that some of it represents the *Niagara beds*.

No. 22 could not be measured exactly since the river in cutting through it makes but a small and varying angle with the strike of its rocks; it cannot be more than 100' in error, however. It is a brown olive shale, and near its center were seen great numbers of *Atrypa reticularis* and a single fragment of *Dalmanites sp ?*

Not quite all of the *Bloomsburg red shale* was seen at this locality, since the exposure begins a few feet below its top, not more than 25,' however, as some fragments of pale green limy shale were observed which must have come at about that horizon. This red shale is finely exposed to the weather along the cuts in the road, dipping at an angle of 40° S. 10 E., and at several horizons the shale has been partly deprived of its iron, leaving the beds a bright pale green exactly like the lowest division of the *Salina* in New York as described by Hall and others.

Lingulas.—This locality is very interesting from the fact that it has furnished (in No. 2) the only organic remains found by me in the *Bloomsburg red shale* in this region,

Section along the railroad, across the Selinsgrove anticlinal.

Fig. 93. Fig. 92.

viz: a large number of *Lingulas* so badly preserved that specific identification was impossible.

This section terminates in the edge of Montour county, Mahoning township, where the river having cut northward against the foot of Montour ridge exposes the lowest rocks seen in my district (No. 23,) a greenish-gray and reddish, very hard, massive sandstone often filled with small quartz pebbles. As I know of no such stratum in the *Clinton*, I have considered this lowest member of the section as representing the top of the *Medina sandstone.*

Barometric elevations in Point.

Forks of road near J. V. Hopewell's,	750′
" " next north,	785′
" " near C. J. Lesher's,	640′
" " " Watson's School-House,	685′
Cross-roads next east,	630′
Johnson's run near F. Doyle's,	565′
Forks of road next east,	625′
Johnson's run near J. Guier's,	500′

72. *Upper Augusta township.*

This township follows the North Branch and main river southward eight miles to nearly opposite Selinsgrove.

Shamokin creek flows westward through it.

The rocks of this township extend from the *Catskill* down to the top of the *Salina.*

The former occurs in the *Northumberland syncline*, down which the North Susquehanna river flows along the northern line of this area; and the latter is just brought above river level where the Susquehanna cuts through the axis of the great *Selinsgrove anticlinal arch* 3 miles below Sunbury.

On the south slope of the Selinsgrove arch, the following succession is exposed along the cuts of the Northern Central R. R., beginning at the 134th mile-post and passing northward:

Section along Northern Central R. R., beginning one mile above Selinsgrove Junction (Fig. 92, page 342).

1.	***Oriskany***, cherty, sandy beds, ... visible	20′
2.	Limy shales, gray and concealed with some chert, ...	50′
3.	Impure, gray limestone, and shale, ...	25′
4.	Dark shales, and black slate, with some thin, impure, blackish limestones, and bluish-gray shales, ...	50′
5.	Limestone, massive, hard, somewhat sandy, and fossiliferous, ...	10′
6.	Blue, shaly limestone, ...	5′
7.	Limestone, bluish-gray, massive, fossiliferous, containing several layers of chert in upper half, ...	10′
8.	Blue limestone, interstratified with shales, ...	8′
9.	Impure, bluish-gray limestone, with some magnesian layers, ...	75′
10.	Shaly, bluish-gray limestone, ...	15′
11.	Massive, bluish-gray limestone with many specimens of ***Strophomena rugosa*** near the top, ...	30′
12.	Hard, bluish-gray, curly, impure limestone, weathering rough and into nodules in terraced layers, ...	50′
13.	Shaly limestone, ...	10′
14.	Blue limestone, and shales, ...	12′
15.	Massive, dark-blue and gray limestone, extensively quarried for lime, quite pure, ...	20′
16.	Gray, banded, impure limestones, exhibiting ***columnar structure***, ...	30′
17.	Shales and concealed, ...	10′
18.	Shaly limestone, and limy shales, ...	35′
19.	Dark-blue limestone, pure, ...	8′
20.	Limy shales, ...	8′
21.	Limestone, bluish-black, very pure, extensively quarried, together with No. 19, base of ***Lower Helderberg***, . . .	12′
22.	Buff, shaly and pale-green, impure limestones and limy shales (***Upper Salina***) to level of R. R. at crest of ***Selinsgrove axis*** 150 yards south from the 135th mile-post,	90′
23.	Concealed to level of Susquehanna river, ...	25′

Summary.

Oriskany, ... visible	20′
Stormville shale, Nos. 2-4 inclusive, ...	125′
Lower Helderberg limestone (Nos. 5–21), ...	343′
Salina, Nos. 22–23, ...	115′
Total, ...	603′

Anticlinal.—At the 135th mile-post the rocks turn over and dip rapidly northward; the *Lower Helderberg limestones* soon pass below the R. R. and then the *Oriskany* and *Hamilton* beds in succession.

The following section was obtained on the north side of the *Selinsgrove arch* in passing southward from the little

stream which empties into the Susquehanna river at the mouth of Shamokin creek:

Section along the Northern Central R. R. southward to the crest of the Selinsgrove arch near the 135th mile-post (Fig. 93, page 342.)

1.	Shales, olive brown, with a layer of iron carbonate ½′ thick, both at top and base,		5′
2.	Brown, olive, sandy shales, breaking in long splinter-like pieces,		150′
3.	Concealed, dip N. 10°–15° W. 30°, (doubtful,)		400′
4.	Black slates and shales, (*Marcellus*,)		135′
5.	Concealed,		60′
6.	Dark slaty shale,		5′
7.	Concealed,		50′
8.	Limestone, bluish-gray, once quarried and burned by Beckon and Lantz, (*Selinsgrove limestone*,)		20′
9.	Gray, impure limestones interstratified with much shale,		30′
10.	Bluish and gray sandy shales, uppermost 30′ somewhat limy, (*Selinsgrove shales*,)		150′
11.	Concealed,		20′
12.	*Oriskany*, a series of dirty yellow cherty fossiliferous, limy and sandy beds,		57′
13.	Limy, cherty beds interstratified with much gray shale,		55′
14.	Shaly beds, limy,		5′
15.	Buffish and blue impure limy shales,		10′
16.	Dark shale with abundant remains of a *fucoid* resembling *Buthotrephis*,		10′
17.	Limy shales,		10′
18.	Concealed,		20′
19.	Impure limestone, (*Top of VI?*)		5′
20.	Concealed,		90′
21.	Limestone impure, somewhat massive,		25′
22.	Concealed,		10′
23.	Impure limestone,		2′
24.	Shaly limestone and concealed,		7′
25.	Limestone, bluish-gray, containing *Tentaculites irregularis* and fragments of fossil shells,		1′
26.	Limy shales and shaly limestone,		45′
27.	*Stromatopora bed*, (*Stormville limestone?*)		10′
28.	Bluish-gray limestone, massive,		10′
29.	Gray limestone, weathering into small nodular masses,		75′
30.	Dark blue and gray limestone, good,	*Bossardville limestone.*	25′
31.	Limestone, impure, bluish-gray,		40′
32.	Limy shales and shaly limestone,		45′
33.	Blue limestone, good,		11′
34.	Shales,		2′
35.	Bluish-black limestone, very poor,		10′
36.	*Salina*, buff and pale green shales and shaly limestone to center of Selinsgrove arch,		115′

Summary.

Hamilton and *Marcellus*, Nos. 1-7, inclusive,	805'
Selinsgrove limestone, Nos. 8-9, inclusive,	50'
" shales, Nos. 10-11, inclusive,	170'
Oriskany sandstone,	57'
Stormville shale, Nos. 13-18, inclusive,	110'
Lower Helderberg limestone, Nos. 19-35, inclusive,	413'
Salina,	115'
Total,	1720'
Interval from top of Oriskany to base of *Lower Helderberg*,	580'

No. 3. The thickness of the large concealed interval in the *Hamilton* is quite uncertain, since the dip with which the black *Marcellus* beds No. 4 come down may have changed within the valley (800' wide) across which the interval No. 3 is spread. How much of this would be *Hamilton* and how much *Marcellus* it is impossible to state, but the greater portion probably belongs to the *Marcellus.*

Nos. 8 and 9 are the representatives of what I have termed the *Selinsgrove limestone;* perhaps a portion of the *Marcellus*, since one of its most abundant fossils is *Ambocœlia umbonata.*

As exhibited here it is a light gray rock, with dull, irregular fracture, quite impure in most of its layers, and interstratified with much shale. A quarry was once opened on it by Messrs. Beckon and Lantz, and some of the purest layers which came near the top were burned into lime. It did not slack well, however, and is no longer quarried for that purpose.

The Selinsgrove shales are represented in this section by No. 10, a series of light gray beds containing some limy layers at top and some thin sandy ones throughout. The place of these shales in the series will depend somewhat on the equivalency of the *Selinsgrove limestone* above. If it be *Corniferous* then would the shales represent the *Cauda galli* beyond a doubt, but if the *limestone* be of *Marcellus age* then would the *shales* very probably be of the same. No fossils were observed in them, and hence the only evidence as to age is to be derived from stratigraphical position.

The Oriskany is a mass of impure, limy, cherty beds in

layers 2″–6″ thick, often containing *Spirifera arrecta*, *S. arenosa*, *S. macropleura*, and other fossils.

It is possible that the concealed interval of 20′ in No. 11 should also be placed in the Oriskany since its surface is covered with small blocks of *Oriskany sandstone.* These blocks of *Oriskany sandstone* which have been subjected to atmospheric influences for a long time acquire a character totally different from the rock in its unweathered condition; for having lost their lime and iron through the leaching process they become bleached to a grayish white rock rather porous, and from which the sand grains stand out quite as prominently as from a typical sandstone. They also break in weathering into small cubical blocks none of which are more than 6″ on a side.

The *Stormville shale* apparently includes only Nos. 13–18, and has therefore a thickness of 110′ or 15′ less than on the south side of the arch. It contains some beds of impure, cherty limestone very much like that in the *Oriskany* above, and in the dark shale, No. 16, occurs a species of *fucoid* with narrow, ribbon-like fronds, branching quite irregularly, being exactly like one occurring in the *Stormville shale* in blocks taken from the tunnel of the Grove Bros. at the eastern line of Montour county.

The Lower Helderberg limestone seems to begin with No. 19, a bed of bluish gray, impure limestone of which only 5′ are visible. Allowing this to be the top, the whole group sums up a thickness of (413′–343′) 70′ more than the same limestones on the south side of the Selinsgrove arch. The only chance for mistake in measurement that would lessen this discrepancy is to be found in the concealed interval, No. 20, but as the horizontal distance through this is 180′ and the dip on both sides greater (32°–35°) than 30° the assumed dip, it would seem that the vertical interval represented cannot be much less than 90′ as given.

No. 25. The only *Tentaculites* observed in the *L. H. limestone* anywhere within the district occur in the little bed of bluish-gray limestone represented by No. 25. They occur quite sparingly in this, and seem to be identical with *Tentaculites irregularis.*

The Stromatopora bed, No. 27, is most probably the equivalent of the great *coral reef horizon* in the *Stormville limestone* through Columbia and Montour counties, since it seems to be especially rich in *Stromatopora*. In this, and the 10′ of massive limestone immediately below, were seen *Strophomena rugosa*, *Atrypa reticularis*, *Spirifera sp?* *Favosites helderbergiæ*, *Zaphrentes sp?* and a large *Orthoceras*, probably *O. multicameratum*, besides many fragments of *Crinoids*, especially abundant in No. 28.

The Stromatopora bed was not noted on the south side of the arch, having very probably been overlooked in some of the beds that are little weathered; for on freshly broken or quarried surfaces the *Stromatopora* are with difficulty distinguished from other portions of the rock.

No. 29. The lower portion of No. 29 seems to correspond to the *Stormville cement bed* of Monroe, and to the "Bastard limestone" of the Columbia and Montour quarries. At any rate it is quite impure, and some of it seems *magnesian*, judged by it physical aspect, and then its stratigraphical position harmonizes with such identification.

No. 30 to 35 (=15 to 21 of Sect. 92.) *The Bossardville limestone* appears to begin with No. 30 and end with No. 35′, which would give it a thickness of 133′ on the north side of the arch. These beds are represented on the south side of the arch by Nos. 15–21 of the previous section, (92,) possessing there a thickness of 118′. These Nos. 15, 19, and 21 of the section on the south side of the Selingsgrove arch correspond respectively to Nos. 30, 33, and 35 on the north side of the same; and all have been extensively *quarried* and shipped for burning, for fluxes, and other purposes, along the Northern Central R. R.

Lead and Zinc mine.

Ores of lead and zinc have recently been found between, and in these two lowest beds of pure limestone (Nos. 19 21 on the south side, Nos. 33 and 35 on the north side,) and an attempt has been made to develop the same by Mr. Doughty of Tamaqua.

The *ores* are found at the very crest of the arch, and con-

sist of *Galena* and *Blende* principally. The deposit lies in irregular pockets and patches mixed with much dirt and other waste material, and so far as examined seems to run in a nearly east and west direction. This deposit seems to come at the same geological horizon, viz: At the base of the *Lower Helderberg limestone*, as the *lead and zinc* reported from Center township in Columbia county; and hence it is possible that when properly opened up the mine may prove of workable value.

Specimens of the ores selected at random and sent to Mr. McCreath for analysis gave the results shown on page 100 preceding.

No. 36. *The Salina beds* consist of the peculiar pale green, limy shales and buffish *magnesian limestones which everywhere characterize the Upper Salina in this region.* They are brought above water level for only 115′ here at the crest of the arch, near the 135th mile-post, and immediately turn over and go under again.

As we pass northward from the top of the last section the *Hamilton proper* rises, the dip being locally reversed, and cliffs of dark brown or olive shale stand out along the road almost vertically to a height of 200′ or more, all the way between Arnold's run and where the Northern Central R. R. crosses Shamokin creek. Here (at the latter locality) the *Hamilton beds* are dipping rapidly northward, and the hills suddenly break down into a broad valley which stretches away between the junction of Shamokin creek with the Susquehanna river; extending northward along the latter to its union with the North branch, and eastward along Shamokin creek. These broad valleys have been worn out of the *Hamilton* and *Chemung beds* principally, except toward the North branch where the *Catskill* and *transition VIII–IX rocks* have been eroded.

Shamokin Falls is a ledge of very hard *Hamilton sandstone* which pitches rapidly under the bed of the Susquehanna a short distance below the main portion of Sunbury, making an almost solid wall 4′–5′ high entirely across the channel of the river and nearly at right angles to the same. The canal dam was built on this rocky wall-like projection

so that the natural fall has been partially obscured. I was informed, however, that before the dam was constructed the ledge of sandstone rose 5'–6' above the bed of the river; and through it here and there narrow breaches had been worn to a lower level by the current.

This sandstone, seems the equivalent of the *Selinsgrove Upper sandstone*, which makes the high cliffs along the N. C. R. R. one mile below Selinsgrove junction. As exposed in the river's bed below the dam it is a bluish-gray sandstone, almost as hard as quartzite, polished and smoothed by the action of the water, pitted with deep "pot holes" of almost every size from one inch in diameter to two feet.

A wide bottom land or terrace spreads out in the vicinity of Sunbury at an elevation of 445'–450' A. T.; while from the top of this a second terrace slopes rapidly up to about 525' A. T. Both of these terraces are covered with small rounded bowlders; and they have evidently once been the flood plains of the Susquehanna river.

In building the new bridge on the Reading R. R. across the Susquehanna river at Sunbury, rock bottom was obtained for all the piers at a very slight depth below the bed of the stream, showing that there is no buried channel in this locality.

The *Catskill beds* make lofty cliffs along the North Branch Susquehanna at the northern line of this township and dip rapidly northward into the *Northumberland syncline* which here occupies the bed of the river.

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73. Rush township.

This township lies east of Upper Augusta, along the river all the way eastward to Montour county.

Its streams are all small, the most of them rising on the northern slope of a high ridge of *Chemung* rocks which passes through the southern edge of the township, and flowing directly into the Susquehanna at the north.

Shamokin creek flows west just south from its southern line, almost parallel to the same, and receives the drainage

from the southern slope of the *Chemung* ridge just alluded to.

The rocks exposed in this township extend from the basal portion of the *Catskill* down to the *Lower Helderberg limestone;* though at the most northern point of this area, two miles below Danville, the whole of the *Salina* might be found under the silt deposits along the Susquehanna river.

The Northumberland synclinal axis passes through the northern half of this township, crossing Logan's creek near the forks of that stream at H. Vastine's; passing south of Rushtown and Klinegrove. It holds a narrow belt of *Catskill* along the center of the trough; both north and south of which the rocks rise rapidly and soon bring up the *Chemung* and lower beds.

The Lower Helderberg limestone occurs in the bed of the Susquehanna river under the south end of the bridge at South Danville, where the upper portion only is visible together with several feet of the *Stormville shale.*

In passing up the North Susquehanna from South Danville, the bluffs rise abruptly from 200′–300′ above the river and we pass transversely across the dip, so that the lower beds dip successively under the stream. Here the following succession is exposed along the road between Fox's run and the little stream which empties into the river a short distance above South Danville:

South Danville section, (Fig. 94, page 338).

1. Olive-green sandy beds, containing few fossils and inclined to be somewhat shaly, ... 300′
2. Hard, gray, and dark olive sandy beds, often making massive cliffs, and containing many layers filled with *Stictopora* and other fossils of the *Lower Chemung*, ... 500′
3. Hard, bluish-gray and dark olive sandstones, and very sandy shales, no fossils seen, ... 500′
4. *Genesee shale*, a series of dark slates and shales, perfectly exposed, no fossils seen, ... 300′
5. *Tully limestone*, ... 60′
6. *Hamilton*, sandy, dark olive shales, ... visible 100′

The Tully limestone has been cut directly through in the excavations along the road which descends the river, so that it is perfectly exposed, dipping N. 10°–15° W. at an

angle of 65°–70°, and its thickness was very satisfactorily determined; in fact this is the only locality I found in the region where the thickness could be measured exactly. The rock has a dull light gray, or even buffish color throughout on weathered surfaces, but in some of the layers a dark blue is revealed on fresh fracture. In it were seen *Atrypa reticularis*, *Ambocoelia umbonata*, *Dalmanites colliteles*, and a small *Zaphrentis*.

None of the rock is pure enough to burn for lime.

In the top of the *Hamilton proper* (No. 6) were seen *Spirifera fimbriata*, *S. granulifera*, and *Athyris spiriferoides*.

The rest of the *Hamilton* and the *Oriskany* are covered up under the terrace deposits which line the river in the vicinity of South Danville.

Just opposite the Danville Insane Asylum a ledge of the *Chemung* hard sandstone (in No. 3) extends in a low wall from the south shore of the Susquehanna almost completely across to the northern bank, jutting up 1′–2′ above the level of the river at low water.

The top of the *Chemung* is seen in passing up *Logan's run* a short distance below the forks of the road at J. Reed's; for here the first red beds come down.

The transition VIII–IX rocks occur along the road from Mr. Reed's southward, cropping out in alternate beds of red and olive yellowish shales and an occasional hard green sandstone.

At the forks of the road near H. Vastine's the rocks are quite red and the base of the *Catskill beds* seems to have come down; but the rocks are nearly horizontal here or even rising slightly southward; showing that the *Northumberland synclinal axis* crosses near this point. As we go still further southward the rocks begin to rise quite rapidly and soon bring up the top of the *Chemung*.

Beds of rounded bowlders occur along Logan run just south from the cross-roads, near P. Yost's, at an elevation of 725′ A. T. Also many angular fragments of *Hamilton sandstone* and *Pocono*, as well as *Catskill conglomerate*,

some of more than 2′ in diameter. No evidence of *Glacial action* could be found.

The Hamilton beds are brought up near the south line of the township, and it seems to be the *Selinsgrove Upper sandstone* which makes the high ridge along the southern border; though the surface is so littered up with débris from broken and disintegrated rocks, that none of the beds which make up the ridge could be seen in place.

Barometric elevations in Rush.

	A. T.
Susquehanna river at S. Danville,	435′
Cross-roads south from Wm. McLaughlin's,	540′
Forks of road near J. Reed's,	560′
" " " H. Vastine's estate,	600′
" " " L. D. Meiler's,	625′
Cross-roads near P. Yost's,	700′
Logan's run near W. Swenk's,	735′
Forks of road near A. Swenk's,	825′
Summit of ridge at Baptist church west from last,	855′

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74. Shamokin township.

This is a very large area lying immediately south from Rush and extending eastward past the southern point of Montour to the Columbia county line.

It is drained by Shamokin creek, which cutting through Little mountain in a deep narrow gap, enters the township near the middle of its southern line, and flows northward through its center almost to the northern boundary. Here it veers suddenly around westward at right angles to its former course and keeps along parallel with the north line of the township until the stream passes into Upper Augusta.

Roaring creek also cuts through Little mountain, and passing along the eastern boundary of this township, drains a small region there.

The rocks of this area extend from the *Pocono* down into the *Marcellus*. The former makes *Little mountain*, a long, high, straight range along whose crest runs the south line of the township; while the latter (*Marcellus*) is exposed along

the deeply-eroded valley of Shamokin creek after it veers westward in the vicinity of Reed's station.

The Selinsgrove axis passes through this township north from its center, going directly through Elysburg, and crossing Roaring creek just east from J. Richard's.

It brings up a belt of *Hamilton* rocks all along its course through the township.

The Marcellus black slates are exposed in the bed of Shamokin creek just above Reed's station; and they frequently crop out to the westward along the Shamokin R. R. from Reed's to the western line of the township. In fact the wide valley of Shamokin creek is excavated in these shales and the lower portion of the *Hamilton.*

About one half mile above Reed's station a massive yellowish-gray sandstone dips down, and is exposed in cuts along the R. R. where the stratum is seen to be very much crumpled, frequently changing dip, and extending along the R. R. for nearly a mile. It is most probably the lower portion of the *Selinsgrove Upper sandstone.*

Near Paxinos station a massive sandstone comes down and makes a ridge along the hills west from the R. R., dipping S. 10°-15° E. 20°. It is exposed just west from Paxinos and is there quite fossiliferous, the following species being seen: *Strophodonta demissa*, *Spirifera granulifera*, and *S. mucronata*, together with many fragments of *Crinoids* and other fossils too badly preserved for identification.

As we pass up Shamokin creek from this point the rocks dip rapidly down to the *south* and the *Hamilton shales* (above the *sandstone*) pass under. The new branch of the Reading R. R. from Shamokin to Sunbury makes a deep cut through these dark olive Hamilton beds just at Paxinos station, and in the piles of débris thrown out great numbers of *Tropidoleptus carinatus* were observed.

The Chemung rocks come down only a few rods north from Paxinos station, and the hard, sandy beds of the *Lower Chemung* make great cliffs of rock along the west bank of Shamokin creek, rising in the hills to an elevation of 300′-400′ above the valley, and dipping N. 45°.

The Chemung beds dip at this rate as far as to the mouth of *Miller's run* (3500′) giving a thickness of 2450′ for the *Chemung* at this locality or about the same as that found in other portions of the district.

The *transition VIII–IX beds* begin just below the mouth of Miller's run, and soon dip under and the genuine *Catskill* comes down dipping 40°–45° S.

The Catskill beds continue on southward dipping at the above rate to 100 yards above the 16th mile-post on the Shamokin R. R., when these beds end and the massive gray conglomerates of the *transition IX–X* come in. This is just above Weigh-scales station, thus making the horizontal distance across the *Catskill* and *transition VIII-IX beds* a little over one mile and a half, and the resulting thickness 5500′, or say 4500′ for the *Catskill beds* alone.

The transition IX–X rocks and the genuine *Pocono beds* could not be separated in the gap of Shamokin creek through the Little mountain, since each is largely composed of massive conglomerates the talus from which effectually conceals the detailed structure of the several strata composing the whole. The horizontal distance through the mountain at right angles to the strike is 1575′ from the base of the *transition IX–X* to the top of the *Pocono*, with a dip of 45°–50° S. which would give a thickness of 1200′ for both of these formations, of which probably about 500′ should be credited to the *transition beds* and the rest to the *Pocono*. The gorge of Shamokin creek through these rocks is quite narrow, and the mountain rises at a steep angle on either side to an elevation of 600′–800′ above the stream.

The top of the *Pocono beds* in the Little mountain reaches a short distance southward from the Shamokin line into Coal township, where the *Mauch Chunk red shale* makes a valley nearly 3000′ broad, and then the Pottsville conglomerate comes down at an angle of 45°, making what is known as Big mountain, the northern rim of the Shamokin Anthracite coal field.

The Mauch Chunk shale cannot be less than 2000′ thick in the valley between Little and Big mountains.

At the eastern line of Shamokin township Little mount-

ain is trenched through by *Roaring creek*, and the cut is known as *Bear Gap*. This gorge is nearly as narrow as that along the Shamokin, but the bounding mountain walls are hardly so high nor steep as at the latter locality.

The rocks in Bear Gap dip S. 40°–45°, and the horizontal distance from the top of the *Pocono* to the top of the *Catskill* is about 1700′. This would give 1150′, or nearly the same as that found for the *Pocono* and *transition IX—X beds* in Shamokin Gap.

The Catskill rocks come up about 200 yards south from the toll-gate in Bear Gap, and alternate red and greenish-gray beds are seen rising at the rate of 45°–50° towards the north as we descend Roaring creek.

The Chemung beds come upon Roaring creek a short distance below W. Kriegbaum's, and the hard sandstones of the *Lower Chemung* are finely exposed along the gorge-like gap made by the stream through the Chemung ridge.

The Stony Brook beds of the *Upper Chemung*, with their great wealth of *Leiorhynchus mesocostale*, *Spirifera disjuncta*, *Productus hirsuta*, and other fossils, are also well exposed.

The most abundant fossil seen in the *Lower Chemung* is the small *Stictopora*, which is so universally present in the massive, sandy beds of the *Lower Chemung*, beginning first at about 600′ above the base of these rocks, and extending upward 600′–800′ further.

The lowest beds of the *Chemung* rise above water level on Roaring creek, just below Mr. D. Kriegbaum's mill, and then the top layers of the *Hamilton* are brought up by the *Selinsgrove axis*, making a broad valley along Roaring creek. To the east, however, the valley soon disappears beneath the *Chemung hills*, which cap the *Hamilton rocks* with hard sandstones; while to the west an undulating valley of *Hamilton rocks* seems to extend through to Shamokin creek, at Paxinos, bordered on either side by a high ridge made by the *Selinsgrove Upper sandstone*, as it dips away both north and south from the Selinsgrove axis.

A high ridge borders the northern line of the township, and its southern slope is very steep, especially after Sha-

mokin creek turns westward and flows along the foot of this ridge. It seems to be made by the *Selinsgrove Upper sandstone;* since a dark, slaty shale exactly like the *Marcellus* is found along the bed of Shamokin creek; and also the débris of the sandstone scattered over the slope of the ridge very much resembles the *Selinsgrove bed*, though no fossils were observed in it.

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75. Lower Augusta township.

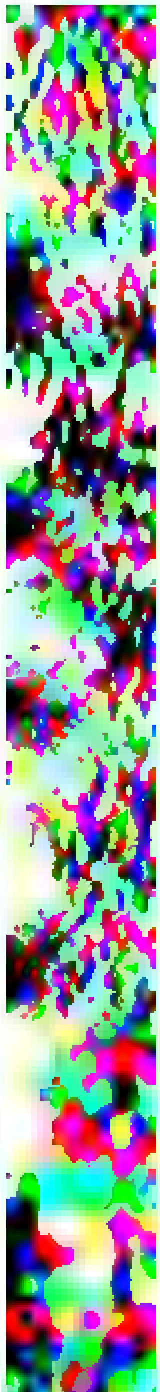
This adjoins Shamokin on the west and extends to the Susquehanna river for its western boundary. The eastern half is drained by Little Shamokin creek, which flows northward entirely across the township and empties into Big Shamokin above Sunbury; while the western half is drained directly into the Susquehanna by Boile run, Hollowing run, and other small streams which head up against the Little Shamokin divide and flow westward to the Susquehanna river.

The Selinsgrove axis passes across the northern half of this township about one mile south from its northern line, bringing up the *Lower Helderberg limestone* and *Oriskany* along the Susquehanna, and a wide belt of *Hamilton rocks* entirely across the township.

The southern boundary of the township is made by the crest of Little mountain, with its *Pocono, and transition IX–X beds.* It joins Line mountain (the southern side of the *Shamokin syncline*) at the river.

There is a westward rise of nearly 500′ to the mile along the axis bottom of the *Shamokin trough*, which crosses the river and N. C. R. R. about one third mile south from the 129th mile-post. North from this, the *Catskill beds* are seen dipping south-east at the rate of 40° up to the 130th mile-post which stands about one eighth mile above the mouth of *Boile's run.*

North from this mile-post everything is covered up by débris along the N. C. R. R. until the mouth of *Hollowing run* is reached, where dark olive *Chemung rocks* dip S.



15° E. 45°. On the north side of Hollowing creek a cut begins on the N. C. R. R. and is almost continuous from this point to Selinsgrove station, one mile and a half above. In passing along these cuts the following section was constructed:

Section along N. C. R. R. between Hollowing run and Selinsgrove station (Fig. 95, page 358).

1.	Dark-olive, sandy, *Chemung beds*,		50′
2.	" beds, containing abundance of *Sticlopora*, to the 131st mile-post at 500′ north from Hollowing run,		270′
3.	Olive-brown, sandy beds, containing *Aulopora tubiformis* 120′ below top,		170′
4.	*Spirifer bed*, containing *S. mesocostalis*, *S. disjuncta*, and *Atrypa hystrix*,		0′ 4″
5.	Dark brown olive sandy beds,		75
6.	*Spirifer bed* containing *S. mesocostalis* and *S. disjuncta* in great members,		0′ 6″
7.	Hard, olive brown, sandy beds,		175′
8.	*Genesee shale*, dark bluish slaty beds, no fossils seen, except a single *Discina* at 155′ below top,		230′
9.	Black slate,		4′
10.	Dark shales,		30′
11.	Concealed, (dip 40°,)		400′
12.	Hamilton olive brown crumbling shales containing small *iron nodules* at several horizons, and the fossils *Athyris spiriferoides*, *Spirifera mucronata Tropidoleptus carinatus*, *Ambocoelia umbonata*, and other forms,		450′
13.	*Selinsgrove Upper sandstone*, a very massive, coarse, yellowish-gray, fossiliferous sandstone which may be subdivided as follows:		202′
	(a) Massive yellow sandstone containing *Spirifera granulifera* in great numbers,	85′	
	(b) Greenish-yellow massive sandstone,	75′	
	(c) *Strophodonta bed*, a perfect mass of *Strophodonta demissa*,	2′	
	(d) Very hard bluish-gray to yellowish-gray sandstone in layers 4″–12″ thick, the lowest 8′ being very massive,	90′	
14.	Dark olive shales with layers of hard, bluish-gray sandstone 6″–10″ thick at 3′–5′,		100′
15.	Dark olive, sandy shales weathering into long, splinter-like pieces,		25′
16.	Sandstone in three layers separated by thin shales, (*Selinsgrove Lower sandstone*,)		5′
17.	Olive brown shales to 132d mile-post,		200′

18. Dark shales and slates often exhibiting cleavage and much weathered so that the bedding planes can only occasionally be made out when the dip is S. 10° E. about 20°, exposed along N. C. R. R. to Water Tank at mouth of Little run, opposite the middle of Clark's island or a distance of 2100′ along the R. R.; thickness cannot be far from . . . . 600′

19. *Selinsgrove Upper limestone.*

(a) Light gray limestone impure with dull fracture containing *Ambocœlia umbonata* and *Aulopora tubiformis*, ...	10′	40′
(b) Drab, limy shales, ...	20′	
(c) Shaly impure limestones containing *A. tubiformis* and other fossils in a very fragmentary condition, ...	10′	

20. *Marcellus shale*, very black fissile slate with *Leiorhynchus limitare* and *Styliola fissurella* in its upper half, no fossils observed in the lower, ... 305′

21. *Selinsgrove Lower limestone*, hard, light-gray limestone, somewhat impure, in layers 1′-3′ thick interstratified with thin layers of gray shale, containing at 15′ above base large numbers of *Ambocœlia umbonata*, and *Leptocœlia acutiplicata*, and in less numbers *Strophomena rhomboidalis*, *Pleurotomaria* sp? *Zaphrentis* sp? thickness, ... 65′

22. *Selinsgrove shale*, a light-gray shale, weathering into splintery-like pieces, and having a few thin layers of impure limestone in the uppermost 35′, no fossils seen; thickness down to top of *Oriskany limestone* in bed of Susquehanna river, ... 140′

23. *Oriskany cherty sandstone*, top seen in bed of Susquehanna river ¼ mile below Selinsgrove junction, ... ——

Summary.

Chemung rocks, Nos. 1-7 inclusive,	No. VIII,	. . . .	741′
Genesee shale, Nos. 8-10 "		264′	2796′
Hamilton, Nos. 11-19 "		2022′	
Marcellus shale, Nos. 20-22 "		510′	
Oriskany, *No. VII*, ...			
Total thickness, ...			3537′

The most remarkable thing about this section is *the great thickness of the Hamilton formation* which here foots up a total of nearly 2800′; and, making due allowance for a possibly diminished dip or even reversed dip within the 400′ concealed interval No. 11, the thickness cannot be less than 2500′—more than double its thickness north from Bloomsburg in Columbia county. Practically all of this increase

is confined to the *Hamilton proper* or middle member of the series; and in examining its structure the reason for the enormous increase (nearly fourfold) is plainly evident; for the portion of the *Hamilton* beginning with the *Selinsgrove Upper sandstone*, No. 13, is entirely absent at Bloomsburg.

No. 8. *The Genesee shale* may be somewhat thicker than that assigned above (264′), since the exposures end with the base of this interval, and nothing else is seen until the general dip would bring up about 400′ more rock, and then the genuine *Hamilton beds* are found. The only fossil seen in the *Genesee beds* anywhere within this district was a single specimen of *Discina*, which unfortunately broke into fragments in an attempt to extricate it from the rock. It very much resembled *Discina lodensis*.

No. 12 is the typical *Hamilton rock* in lithological characters and fossil contents, as everywhere exhibited in Columbia and Montour counties; and, as already stated, it is the basal member of the *Hamilton proper* on the north side of the *Montour axis*.

No. 13. *The Selinsgrove Upper sandstone*, has been designated from the town on the west side of the river opposite the R. R. cut, one mile below Selinsgrove Junction, where the sandstone makes a long, high point coming out to the very edge of the river. It also makes an outcrop in the bed of the Susquehanna projecting ½′–1′ and extending entirely across. Its upper portion is quite fossiliferous and several other species occur in addition to those given in the section.

No. 18. These shales which I have included in the *Hamilton proper* are entirely unlike any of the beds belonging to this epoch north from the *Montour axis* in Columbia, Montour or Northumberland counties, and hence are most probably completely absent there like the sandstones above. They are quite dark and fissile, often much resembling the *Marcellus beds* in structure, though they usually retain the splintery mode of weathering and brownish color common to the *Hamilton*. They frequently exhibit cleavage, and make almost vertical cliffs 100′–200′ high along the N.

C. R. R. above the 132d mile-post. No fossils were observed in them, though no minute search was made.

No. 19. *The Selinsgrove Upper limestone* is light gray, impure, separable into three divisions, having limestones at top and bottom with an intervening shale, the whole being 40′ thick. The beautiful little coral *Aulopora tubiformis* occurs in both upper and lower divisions of the limestone; while *Tropidoleptus carinatus*, and *Coleolus tenuicinctus* occur in the lower division, according to Prof. Claypole's identifications. This limestone rises above the N. C. R. R. track at the water tank, about one half mile below Selinsgrove Junction.

No. 20 unquestionably belongs to the *Marcellus shale;* for Prof. Claypole identified *Leiorhynchus limitare* and *Styliola fissurella* from its upper half. Then, too, the structure and character of the beds themselves are the same as exhibited elsewhere in the district; being a very black, fissile slate, containing irregular concretions of limestone near its base. It is completely exposed along the cuts of the N. C. R. R. and is quite pyritous near the base.

The Selinsgrove limestone comes directly under the black *Marcellus shale* of the section, and emerges from the N. C. R. R. about one half mile below Selinsgrove Junction where it arches up into a great cliff, bordering the east bank of the Susquehanna river. The base of the stratum attains an elevation of 140′ above the river on the crest of a *local axis.* Then the dip is reversed and the limestone sinks north beneath Selinsgrove Junction.

I have included this bed in the *Hamilton series* as a portion of the *Marcellus.* The reasons for this are fully set forth in Chap. IV, page 82. Only one fossiliferous streak was found in this limestone, and that comes within 15° of its base. From it I obtained the fossils given under No. 21, which are identified by Prof. Claypole. *Ambocœlia umbonata* is most abundant, and *Leptocœlia acutiplicata* comes next to it.

No. 22. *Selinsgrove shale* is the name by which I designate the series of ashen gray beds which immediately underlie the limestone, and extend down to the *Oriskany sandstone,*

having a thickness of 140′ at the point where they are seen about one fourth mile below Selinsgrove Junction. They are somewhat limy at top and some thin layers of impure limestone occur in the uppermost 35′. These beds have also been referred to the *Marcellus*, but of course if the *limestone* should turn out to be *Corniferous*, the shales would represent the *Cauda galli grit*, and it is possible that the bottom portion may belong to the *Cauda galli*. No fossils were observed in these shales, and hence no evidence of their stratigraphical equivalence can be adduced from that source.

In passing up the Susquehanna river from Selinsgrove Junction, the rocks are concealed; but a *south dip* evidently continues for nearly one half mile, since, at the very northern line of the township, on the river, one mile above Selinsgrove Junction, the *Oriskany sandstone* comes up with a steep south dip, and begins the section given in Upper Augusta township on a preceding page.

The Oriskany chert makes a bold ridge along the northern line of Lower Augusta just east from the Susquehanna river where the neck from Upper Augusta township projects southward. It also extends some distance eastward and sinks along the axis before reaching *Little Shamokin creek*.

High Drift.—Rounded bowlders in a great heap extend up the east bank of the Susquehanna river opposite the water tank below Selinsgrove junction. They end on a gentle slope at 215′ above the present channel bed of the Susquehanna or about 625′ A. T. The bowlders are principally sandstone, but among them were seen pieces of the *Iron sandstone* from the *Clinton* and *chert* from the *Lower Helderberg* and *Oriskany*.

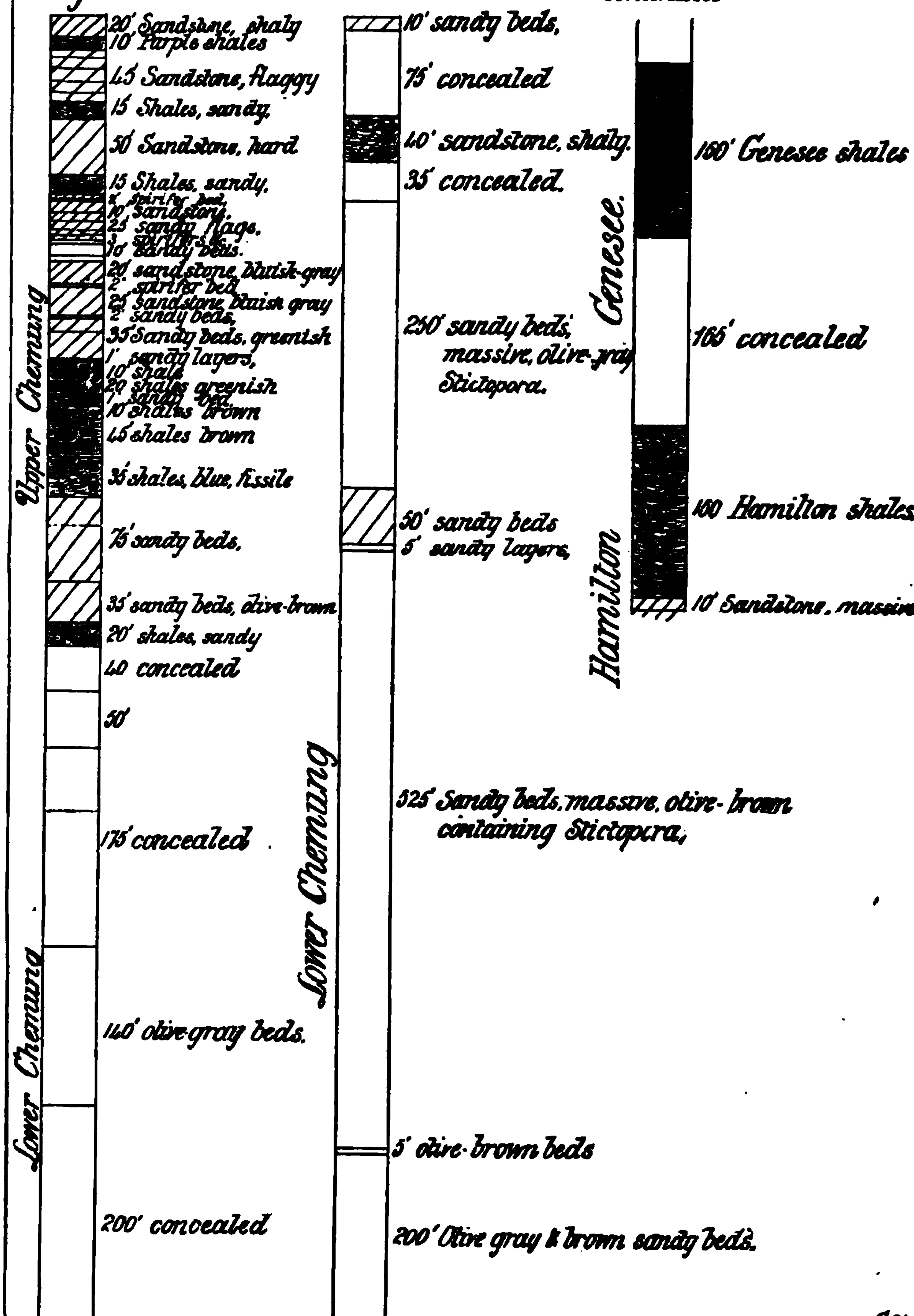
In ascending the hill on the same slope above where the highest of the rounded bowlders occur, nothing but angular fragments of the country rock is found; so that 215′ seems to be the highest point reached here by the true *Drift*.

The Susquehanna valley is about two miles wide at this point.

Plate. XXIX.

Section along the Northern Central Railroad.

Fig. 96.



G7.

76. Jackson township.

This is a small area which borders the Susquehanna river just south from the south-west corner of Lower Augusta.

Mahanoy creek enters it near its north-east corner, cutting through Line mountain out of the *Mauch Chunk red shale valley*, and flowing south nearly to the center of the township, where it turns westward and with many windings flows into the Susquehanna near Treverton junction.

The rocks of this township belong to the series from the *Pocono* down to the top of the *Hamilton*.

The Pocono conglomerates make the crest of Line mountain which forms the northern boundary- South of this the *Catskill* and *Transition VIII–IX* spread a wide band of *red* to some distance beyond the center of the township.

The Chemung beds cover the southern portion of Jackson, except a narrow strip along the extreme southern border east from the Luth. Church near H. Peifer's.

Here the *Genesee* dark shales dipping N. 40°.

In passing northward from the Lutheran church the *Chemung beds* are seen dipping rapidly north, and the *Stony Brook fossiliferous beds* are seen along the road opposite Mr. I. Smith's, filled with *Productella hirsuta*, *Leiorhynchus mesocostale*, *Spirifera disjuncta*, and other of the forms commonly found at that horizon.

The Selinsgrove Upper sandstone makes a high ridge along the southern line of the township, and Fiedler's creek cuts through the same near I. C. Lehman's, where the top of the massive yellowish gray sandstone is seen dipping northward at the rate of 40°–45°, and above it the olive-brown *Hamilton* shales are seen.

The base of the *Transition VIII–IX beds* cap the hills just east from Treverton Junction, or Herndon Station.

Barometric elevations in Jackson.

	A. T.
Forks of road near H. Peifer's,	500′
Cross-roads at P. Botteiger's,	810′
" near N. Bower's,	725′
Forks of road near C. Leader's,	800′

77 *Lower Mahanoy township.*

This township is situated directly south from Jackson, and is bordered by the Susquehanna river on the west, extending southward to Dauphin county, from which it is separated, along its southern boundary, by Mahantango creek, which, flowing eastward, drains the southern half of the township into the Susquehanna river. All the other streams are small, and flow directly into the Susquehanna.

The rocks exposed in this township belong to that part of the column between the middle of the *Catskill* and the top of the *Salina.*

The *Georgetown axis*, crosses the Susquehanna river at Georgetown, and runs eastward across the northern half of the township, bringing the *Upper Helderberg limestone* to the surface. There are in fact two arches separated by a shallow syncline of *Hamilton rocks* nearly a mile wide at the river.

The Selinsgrove Upper sandstone, in massive layers, comes down with rapid dip both north and south from this double arch, and makes a bold ridge on either side, the southern one being known as *Fisher's ridge*, and the northern one as *Swartz's ridge.*

In passing southward from near the northern line of the township, on the Susquehanna river, the following section of the *Chemung beds* is exposed in the cuts R. R.:

Section along the N. C. R. R. in passing southward from Fiedler's creek beginning 300 yards south from the 125th Mile-post, (Fig. 96, page 364.)

1.	Greenish shaly sandstone,	20′
2.	*Purple shales,*	10′
3.	Sandstone, greenish-gray, flaggy,	45′
4.	Shales, sandy with a tinge of purple on weathered surfaces, containing *Avicula tricostata* and *Spirifera disjuncta,*	15′
5.	Sandstone, hard greenish-gray,	50′
6.	Sandy shale, weathering purplish,	15′
7.	Sandstone, green, ripple-marked,	5′
8.	*Spirifer bed* (principally *S. disjuncta,*)	2′
9.	Sandstone, bluish,	10′
10.	*Spirifer bed* (*S. disjuncta,*)	1′
11.	Bluish, sandy flags,	25′

12.	Greenish-gray, sandy beds filled with *Spirifers*, *Productella* and *Rhynchonella*,	3′
13.	Sandy beds weathering purplish,	10′
14.	Bluish-gray sandy beds containing *Spirifera disjuncta*, *Productella hirsuta* and *Sanguinolites sp?*	5′
15.	Sandstone, bluish-gray, flaggy below,	20′
16.	*Spirifer bed*, also containing *Productella*,	2′
17.	Sandstone, bluish-gray,	25′
18.	Grayish-brown sandy bed filled with large *Spirifers* (*S. mesostrialis*,)	2′
19.	Greenish-gray, sandy beds,	35′
20.	Green, sandy layer covered with *Productella hirsuta*, *Leiorhynchus mesocostale* and *Rhynchonella contracta*,	1′
21.	Shales, light green, containing *Leiorhynchus mesocostale*, *Discina media*, *Nucula corbuliformis*, *Chonetes setigerus*, and many others,	10′
22.	Greenish shales containing several species of *Nucula*,	20′
23.	Greenish-brown sandy bed covered with *Leiorhynchus mesocostale*, and *Rhynchonella*,	1′
24.	Brown shales,	10′
25.	Brown shales, containing *Avicula tricostata* several species of *Nucula*, and *Productella hirsuta*,	45′
26.	Bluish, fissile shales,	35′
27.	More massive, olive-brown, sandy beds, sparingly fossiliferous,	75′
28.	Olive-brown sandy beds filled with *Orthis impressa*, *Spirifera mesostrialis*, *Strophodonta perplana*, *var. nervosa*, *Leiorhynchus mesocostale*, *Productella hirsuta*, *Spirifera disjuncta*, and many others,	35′
29.	Olive-brown sandy shales,	20′
30.	Concealed,	40′
35.	Here a great change in lithology takes place, the beds becoming harder and breaking by weathering into long, splintery-like pieces,	50′
36.	Concealed,	175′
37.	Massive, hard, olive-gray beds, containing *Crinoidal stems*,	140′
38.	Concealed,	200′
39.	Grayish, olive sandy beds,	10′
40.	Concealed,	75′
41.	Hard, greenish-gray and olive, shaly sandstones,	40′
42.	Concealed,	35′
43.	Massive, olive-gray sandy beds, containing *Stictopora* throughout,	250′
44.	Gray, sandy, less massive beds,	50′
45.	Gray sandy layers filled with *Stictopora*,	5′
46.	Massive, olive-brown sandy beds making cliffs, containing very few fossil shells, but many *Stictoporæ* at several horizons,	525′
47.	Olive-brown beds containing *Aulopora tubiformis*,	5′
48.	Olive-gray, and brown sandy beds making cliffs, no fossils seen to base of *Chemung* at 124th M. P.,	200′

49. *Genesee shales*,	visible	150'
50. Concealed,		165'
51. *Hamilton shales* to mouth of small run near J. Borden's,		150'
52. Massive, yellowish-gray sandstone (Selinsgrove?),	visible	10'

Summary.

Transition VIII–IX beds Nos. 1–2 inclusive,		30'
Upper Chemung, including *Stony Brook beds*, Nos. 3–30 inclusive,	502'	2322'
Lower Chemung, Nos. 31–48 inclusive,	1820'	
Genesee and Hamilton,	visible	475'
Total,		2827'

It is possible that the thickness of the *Lower Chemung* (1820') as given above should be slightly increased; since the dip, which varies between 30° and 40° N. 10° W., was usually taken nearer the minimum than the maximum in the construction of the section.

No. 28 seems to represent the base of the *Stony Brook beds*, which by the section would come 1820' above the base of the *Chemung*, a result differing from measurements obtained in other portions of the district by only 50' or 100'.

No. 2 of the section is a purple, reddish shale and seems by its stratigraphical position to be identical with the *lowest red bed* found in other portions of the region, which I have regarded as the dividing line between the *Chemung proper* (VIII) and the *transition beds* (VIII–IX) which exhibit *Catskill affinities*.

Some of the beds below this exhibit a faint *purplish* color on the weathered surface; and occasionally the same color permeates entirely through a thin layer; but the freshly broken unweathered layers do not exhibit it, being generally bluish-green within; showing that the *purple* color is derived from chemical changes consequent on exposure to atmospheric influences, and is not constituent, as in No. 2, in which the whole mass is purplish-red throughout.

In passing southward from the mouth of *Bordner's run*, where the previous section ends, the outcrops are concealed along the Susquehanna river by heaps of débris from the *Selinsgrove Upper sandstone*, whose fragments, broken into bowlders 4″–6″ in diameter, cover the surface to a great depth.

This sandstone rises from the bed of the Susquehanna at Bordner's run and arching into the air makes the crest of a high ridge; but turning sharply over the northern fold of the *Georgetown double arch* it descends below the river and emerges a second time just below Mr. J. Bachman's, where its hard, massive beds make a long, low dike-like outcrop entirely across the Susquehanna river, rising out of the same on a dip of 45° N. 10° W. Many of the layers project 4″–8″ above low water in the river at some places while in others the beds are abraded down to the bed of the stream.

In descending the Susquehanna river from Bachman's the rocks continue rising quite rapidly, and just above Georgetown the *Lower Helderberg limestone* comes up and has been quarried to some extent just north from the Lutheran church, where we see 50′ of buffish impure limestone immediately underlain by 25′ of *bluish black limestone* which is quarried and burned. This last seems to represent the top of the *Bossardville series* while the overlying impure beds would be identical with the "*Bastard limestone*" of the Columbia county quarries.

The rock dips N. 10° W. 40°.

After passing a short distance south from Georgetown the *Upper Salina beds* are brought above river level on the crest of the southern branch of the *Georgetown arch*, when the rocks turn over and dip down rapidly to the south, so that one mile below Georgetown the *Lower Helderberg limestone* comes down and passes beneath the Susquehanna river together with the overlying beds, which are well exposed nearly to the top of the *Hamilton* in the cuttings along the N. C. R. R. as follows:

Section seen along the N. C. R. R. beginning 100 yards south from 120th mile-post and passing northward, (Fig. 97, page 370.)

1. *Selinsgrove Upper sandstone*, massive yellowish-gray,	visible 100′
2. Olive brown shales,	300′
3. *Selinsgrove Lower* sandstone, gray, massive,	10′
4. Shaly sandstone and shales,	40′

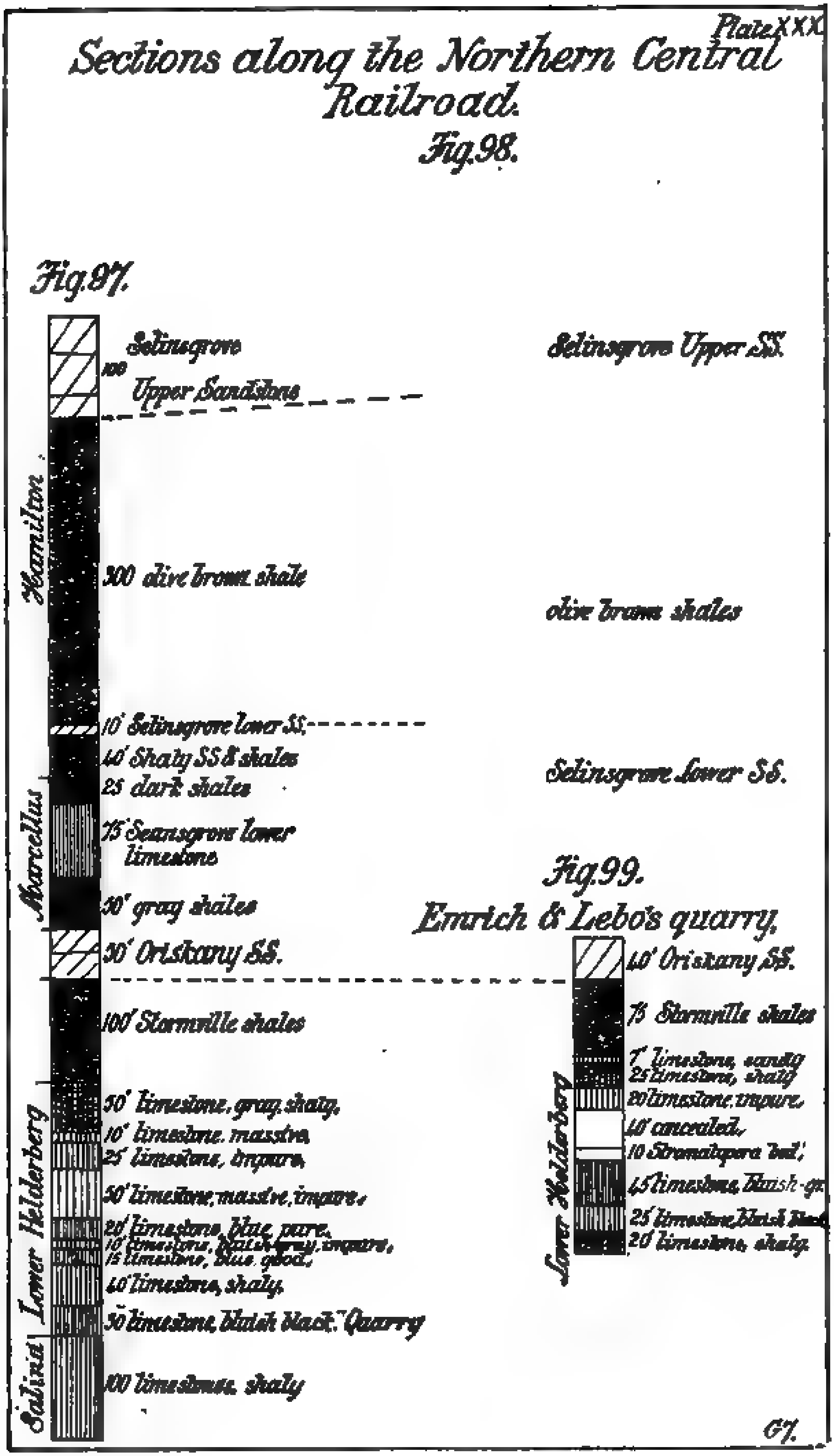


Plate XXX
Sections along the Northern Central Railroad.
Fig. 98.
Fig. 97.
Selinsgrove
100
Upper Sandstone
Selinsgrove Upper SS.
Hamilton
300 olive brown shale
olive brown shales
10' Selinsgrove lower SS.
40' Shaly SS & shales
25 dark shales
Selinsgrove Lower SS.
Marcellus
75' Selinsgrove lower limestone
30' gray shales
Fig. 99.
Emrich & Lebo's quarry.
30' Oriskany SS.
40' Oriskany SS.
100' Stormville shales
75 Stormville shales
7' limestone, sandy
25 limestone, shaly
20 limestone, impure
40' concealed
10 Stromatopora "bed"
45 limestone, bluish-gr
25 limestone, bluish black
20 limestone, shaly
Lower Helderberg
50' limestone, gray, shaly
10' limestone, massive
25' limestone, impure
50' limestone, massive, impure
20' limestone, blue, pure
10 limestone, bluish-gray, impure
15 limestone, blue, good
40 limestone, shaly
30 limestone, bluish black. Quarry
Lower Helderberg
Salinia
100 limestones, shaly
67.

5.	Dark shales,	25′
6.	Hard shaly limy beds containing a few layers of impure limestone, the whole representing the *Selinsgrove Lower limestone*,	75′
7.	Gray shales, (Selinsgrove,)	50′
8.	*Oriskany sandstone* rather massive and quite fossiliferous, slightly cherty,	50′
9.	*Stormville shales*, gray and dark with some layers of chert near center,	100′
10.	*Limestone*, gray, shaly, fossiliferous,	50′
11.	Bluish-gray massive limestone, fossiliferous,	10′
12.	Impure, buffish gray limestone,	25′
13.	Bluish-gray massive, impure, fossiliferous limestones,	50′
14.	Blue limestone, pure,	20′
15.	Bluish-gray impure beds,	10′
16.	Blue limestone, good,	15′
17.	Shaly, impure, bluish-gray limestones,	40′
18.	Bluish-black limestone, quarried, quite pure,	30′
19.	Drab and buffish gray shaly limestones, and limy shales to base of exposure about one mile below Georgetown, (*Salina Upper*,)	100′

Summary.

Hamilton proper, Nos. 1–4, inclusive,	450′
Marcellus, Nos. 5–7, inclusive,	150′
Oriskany sandstone, (VII,)	50′
Stormville shale, (VII-VI,)	100′
Lower Helderberg limestone, (VI,)	250′
Salina,	100′
Total,	1100′

This section shows a very striking change in the lower portion of the *Hamilton* from that exhibited in section 95, below Selinsgrove junction only 12 miles north from this locality.

For, there the *Marcellus black shale* is 305′ thick and the whole *Marcellus* 510′, and the interval from the base of the *Selinsgrove Upper sandstone* down to the *Oriskany* nearly 1500′; while in this section below Georgetown the *Marcellus black slate* is *absent* entirely, unless the 25′ of *dark shale* in No. 5 should be its feeble representative, the entire *Marcellus* is only 150′ thick, and the interval from the base of the *Selinsgrove Upper sandstone* to the *Oriskany* is only 500′ instead of 1500′ as at Selinsgrove.

This great reduction in thickness is accompanied by a corresponding change in character, another massive sandstone being introduced at the base of the *Hamilton* proper.

It is possible that the *Marcellus* and *lower Hamilton* were eroded from this region previous to the deposition of the *Selinsgrove Lower sandstone.*

No. 6. *The Selinsgrove Lower limestone* seems to be represented by a mass of very hard, gray, limy shale containing a few layers of very impure gray limestone.

No. 7. *The Selinsgrove shale* is only 50′ thick instead of 140′ as at Selinsgrove junction.

No. 8. *The Oriskany* is here quite massive, exhibiting much less of the *cherty* character which distinguishes it further north. It is also fossiliferous, *Spirifera arenosa,* and *Rensselæria ovalis* being quite abundant, as well as several other forms which were too badly preserved for determination.

The Lower Helderberg limestone is largely composed of impure beds only 65′ of the 250′ being pure enough for use in burning into lime.

No. 18 is the purest portion of the *Bossardville limestone* represented by a blackish-colored rock which has been extensively quarried along the N. C. R. R.

In passing south from the top of the last section the rocks keep dipping rapidly down until the *Chemung beds* descend, and a considerable portion of that series passes below the level of the Susquehanna river, the bottom of the sharp trough being reached about half way between the 120th and 119th Mile-posts.

Then the rocks turn over and rise to the south again, the *Selinsgrove Upper sandstone* finally coming up together with the underlying shales, and just below the 119th milepost a very massive sandstone arches up and makes a vertical cliff 100′ high. This sandstone comes at the same horizon as Nos. 3 and 4 of the last section, and has been termed the *Selinsgrove Lower sandstone.* The rock is grayish-white with a tinge of pink, and comes in layers 1′–4′ thick.

It makes two lines of outcrop across the bed of the Susquehanna river, since it arches over and immediately dips under again to the south as the crest of a *subordinate axis* passes directly along the strike of this sandstone.

In going southward from the 119th mile-post the rocks

pitch down at the rate of 40°, and the following section is exposed along the N. C. R. R.:

Section along N. C. R. R. southward from 119th mile-post, (Fig. 98, page 370.)

3.	*Selinsgrove Upper sandstone,*	300′
2.	Olive brown shales, lower 50′ somewhat sandy,	325′
1.	*Selinsgrove Lower, massive sandstone,*	100′

No. 3. The S. U. sandstone is very hard, varying from greenish-gray to yellow in color, much of it being massive. It is here 100′ thicker than at Selinsgrove.

No. 2 has the general aspect of the typical beds in the *Hamilton proper*, so far as the physical aspect is concerned, but no fossils were observed in them, though nothing like a careful search was made.

In passing south from where the *Selinsgrove Upper sandstone* goes under the river the rocks still continue dipping rapidly, (40°–45°,) and the *Chemung beds* are very soon brought down, in fact they come in so soon after the *Selinsgrove U. S. S.* makes its long outcrop across the bed of the Susquehanna that not more than 350′–400′ of rock can intervene between the top of the *Selinsgrove Upper sandstone* and the base of the *Chemung.*

At the mouth of the Mahantango creek a wide flat covered with alluvial deposits conceals everything from view, but it cannot be far from the outcrop of the *Catskill beds.*

In the vicinity of Georgetown a broad level *terrace* is seen at 125′ above the level of the river, covered with sand and loam.

The Lower Helderberg limestone is exposed along the road near Mr. P. Whitman's, about one half mile east from Georgetown dipping south. The portion seen belongs near the base of the *Lower Helderberg* and may possibly be in the top of the *Salina.*

Further east on this road and about one half mile east from Hickorytown the *Lower Helderberg limestone* is quite extensively quarried by Mr. W. Phillips, just south from the road, where the bluish-black *Bossardville limestone* dips southward at the rate of 30°. This dip carries it into

the air over the valley of *Georgetown*, run to the north; but the limestone comes down on a north dip and is mined at several localities along the hill about one third mile north from Mr. Phillips', by Messrs. B. Phillips, Snyder, Long, and others.

The Oriskany sandstone is exposed just south from Hickorytown, dipping southward quite rapidly, (40°–45°,) and then gray and dark shales come down for a short distance. Then the surface is covered with débris and everything concealed until the *Selinsgrove Upper sandstone* dips down and makes Fisher's ridge. The top of this sandstone is seen at the forks of the road near J. Dentery's where it dips S. 10° E. 70°. It is quite massive and of a yellowish-gray color. The ridge rises to an elevation of 850′ A. T., though where the road crosses the same south from Hickorytown it is nearly 100′ lower.

The east and west road along the south slope of Fisher's ridge runs on top of the *Selinsgrove Upper sandstone* for nearly the entire length of this township.

The Catskill beds are seen coming into the section at the eastern line of this township, just opposite Mr. W. Heitzman's on the road which leads southward along Sheffer's run. The rocks are quite *red* and dip S. 10° E. 75°.

North from this along Sheffer's run we see the variegated (red, green, and olive) beds of the *transition* (*VIII–IX*) cropping out at a high angle of dip to the south, until we come to 200 yards north from the cross-roads at the township line where the lowest *red bed* rises into the air and the *Chemung beds* come up and extend along the road north to where it crosses Sheffer's run just south from C. Snyder's.

Here *Hamilton beds* rise at an angle of 70° and continue along the road to the forks of the same near E. Byerly's, where the Selinsgrove Upper sandstone comes up dipping S. 10° E. 75°–80°. It is quite massive and carries Fisher's ridge up to an elevation of 800′ A. T.

The Oriskany sandstone comes up at Mr. J. Sheffer's, 70 rods north from Byerly's, and a short distance further north, the *Georgetown axis* throws the *Lower Helderberg limestone* into the air. Coming down to the north on a

rapid dip this makes a long line of outcrop along the north slope of Fisher's ridge, just west from the road. It has there been extensively quarried by Messrs. Byerly, Sheffer, Bayer, and others, and burned into lime for agricultural purposes chiefly. There are about 30′ of the rock exposed and it is a portion of the *Bossardville limestone.*

The Oriskany sandstone soon goes under and at the School-House just north from the limestone-quarries the dark shales of the *Hamilton* come down and make a blackish outcrop along the road.

A few rods further north we reach the bottom of the trough, and the dip being reversed to the south, the *Hamilton* dark-brown shales arch into the air revealing below them a very hard, gray sandstone, 25′ thick, which would be the *Selinsgrove Lower.*

Then below the last stratum and separated from it by a few feet of shales there comes up an impure limestone and limy shales 50′–60′ thick which would represent the *Selinsgrove Lower limestone.*

The Oriskany sandstone comes up in its turn and makes a ridge running east and west just north from B. Byerly's and the south dip continuing the *Lower Helderberg limestone* appears.

This is brought up by the northern *Georgetown sub-axis* which crosses at the forks of the road 93 rods north from B. Byerly's.

The Lower Helderberg limestone is quarried by Messrs. Emerich and Lebo just south from J. Wirt's, where it dips north at the rate of 50°–60°, and exhibits the following section at the quarry and along the road north from it:

Section of L. H. limestone at Emerich and Lebo's quarry (Fig. 99, page 370.)

1.	***Oriskany sandstone***, **yellowish-gray, contains some chert, visible,**	**40′**
2.	***Stormville shales***, **ashen-gray to dark brown, some of them limy and others cherty, *fossiliferous*, *Spirifera macropleura* and *Strophomena depressa* being quite abundant,**	**75′**
3.	**Massive sandy limestone, full of chert,**	**7′**
4.	**Shaly limestone and concealed,**	**25′**

5.	Massive, impure limestone, bluish-gray, cherty at top for 5',	20'
6.	Concealed,	40'
7.	*Stromatopora bed*, a bluish-gray limestone filled with fossil corals of which *Stromatopora concentrica* is most abundant,	10'
8.	Bluish-gray limestone, impure, having the "Bastard bed" as the lower half,	45'
9.	*Bluish black limestone*, quite pure,	25'
10.	Impure shaly limestone to bottom of exposure,	20'
	Total,	307'

The Oriskany sandstone is quite massive and makes a prominent ridge along its strike. It contains less chert than usual, being more of a sandstone. *Spirifera arenosa* was observed in some of its fragments.

The Stormville shale contains several thin beds of *chert* near its center, and has only a small thickness of *dark shale*, the most of it being ashen-gray.

The Stromatopora bed is a perfect mass of fossil *Stromatopora*, *Favosites*, and other corals. It occurs here at 92' below the top of the *Lower Helderberg limestone*, which is several feet lower than its customary horizon, (50'–60' below the top,) and this renders it probable that the *Stormville shale* should really include No. 3–4 which would make it 107' thick, since this would agree better with the thickness of that interval as found in other portions of the district, and would also reduce that portion of the *Stormville limestone* above the *Stromatopora bed* to 60'.

The Stormville shale often contains thin beds of limestone, and these may have thickened up at the present locality.

No. 9 is the only portion of the *Lower Helderberg limestone* that is pure enough for burning. It very probably represents the upper portion of the *Bossardville limestone*, since it has the blackish color and flag-like structure of that stratum.

In passing northward from the last locality the *Hamilton rocks* soon dip down, and the *Selinsgrove Upper sandstone* is seen making a long high ridge through which Bull run cuts a narrow channel at the northern line of this township. The sandstone seems to be nearly 300' thick, and its top

goes under water level to the north just where the road crosses Bull run at I. C. Lehman's, dip 40°–45° N. 10° W.

Just above the *Selinsgrove Upper sandstone* come coarse, greenish, sandy beds for about 250′, and then soft, olive brown crumbling shales.

Barometric elevations in Lower Mahanoy.

	A. T.
Cross-roads just below Georgetown,	475′
By-road at P. Whitman's,	470′
Forks of roads south from J. Spott's,	595′
Cross-roads in Hickorytown,	700′
Gap in Fisher's ridge just south,	765′
Forks of road near J. Dutery's,	735′
" " at Luth. Ref'd Church,	765′
" " near W. Shaffer's,	765′
" " one mile south-east of last,	600′
Cross-roads at tp. line 39 rods north of last,	610′
Forks of road near E. Byerly's,	740′
" " J. Shafer's,	770′
" " School-house,	675′
" " B. Byerly's,	625′
" " 93 rods north of last,	615′

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78. Jordan township.

This is a long, narrow area which lies directly east from Lower Mahanoy, and like it is separated from Dauphin county on the south by Mahantango creek, which flows in a wide valley worn out of the *Catskill red shales.*

The northern line of this township is the crest of *Swartz's ridge*, made by the north-dipping beds of the *Selinsgrove Upper sandstone.*

Fisher's ridge is an almost exact counterpart of the former, made by the same sandstone as it dips southward from the arch of the *Georgetown axis.* The crests of these two ridges are more than a mile apart at the western line of this township but they approach each other gradually toward the east and finally unite at the extreme north-eastern point of the township. This running together of the two ridges seems to be due primarily to the fact that the sharp syn-

cline which occurs between them at the west flattens out, eastward and leaves but a single arch.

The southern fold of the *Georgetown double axis* seems to be the one which flattens out, and thus causes the intermediate syncline to disappear, since it does not bring up the *Lower Helderberg limestone* anywhere except at the eastern line of the township, while the northern fold exposes this limestone for more than two miles in an east and west line, or from Mouse creek to its western boundary.

There are many quarries in the *bluish-black portion* of this limestone, or No. 9 of the previous section, between the western line of the township and Mouse creek, Messrs. Wirt, Adam, Wentzel, Philips, Shafer, Kobel, Swartz, and several others having quarries in this stratum.

APPENDIX A.

(From Geology of Pennsylvania, Vol. I, pp. 440 to 450; 1858.)

BY H. D. ROGERS.

Anticlinal Belt of Montour Ridge.

The anticlinal belt of Montour Ridge is a long and ample flexure or wave in the strata, commencing in the Ponent rocks near the sources of the Wapwallopen, and terminating W. in Buffalo Valley, in Union county. It comprises the Levant, Pre-meridian, Meridian, Cadent, and Vergent rocks. In the axis or medial line of this enormous wave rises the beautifully symmetrical crest of Montour Ridge, overarched by the middle or iron-bearing members of the Surgent series. This ridge is almost perfectly straight, and of very regular form. Its highest and widest part is in the vicinity of Danville, but it maintains a nearly level summit for a great length E. and W., and declines at each extremity in a long gradual slope into the plain. Its greatest height is about 600 feet, and its mean breadth perhaps three fourths of a mile. From its E. termination near Espytown to its W. at the Susquehanna, 4 miles N. of Northumberland, the whole length of the crest is very nearly 27 miles. A low valley, generally less than half a mile in width, lies immediately at the foot of the mountain, bounding it on each side, as it were, by a broad fosse. Each of these vales is excavated in a belt of the soft Scalent marls, Pre-meridian, Meridian, and Cadent strata, and outside of each is a broad continous undulating range of monoclinal hills forming their outer boundary, and encircling Montour Ridge in the form of a low broken rampart. These two zones of hills consist of the thick and resisting formations

of the Vergent flags and the Vergent shales, each belt of strata dipping from the axis of the general anticlinal wave. They close together beyond the termination of Montour Ridge, and range thence as a single anticlinal tract of the series. That at the W. end of the Ridge passes but a short distance into Union county before it becomes lost in the wider synclinal basin of the Blue Hill belt, while that at the E. end ranges up the valley of the N. Branch and Wapwallopen, nearly to the head of this latter stream.

Structure and contents of Montour Ridge.

In describing Montour Ridge as a regular anticlinal wave in the strata, I would not convey the idea that it is perfectly symmetrical in its structure. It exhibits, on the contrary, important deviations from strict anticlinal symmetry. It is really constituted of two anticlinal crests not precisely in a line with each other, one N. of Bloomsburg declining toward the valley of Hemlock Creek, and the other, and by far the longest, rising near this stream on the S. flank of the first, and terminating near Northumberland. Where the two axes thus overlap, or, more correctly, where the two waves thus coalesce laterally near their extremities, the line of the E. crest is nearly one fourth of a mile N. of that of the W. To this fortunate doubling of the flexure at Hemlock Creek is due the spreading out, at a shallow depth below the surface, of the fossiliferous ore, which is supported on the backs of two broad waves in place of one. The better to convey a clear conception of the structure of the ridge in the different portions of its length, I shall here introduce several sections (Figs. 81, 82, 83), one illustrative of the main ridge at Danville, another of the double wave at Hemlock Creek, and a third of the Eastern Ridge at Fishing Creek.

A glance at the first of these sections shows us that the flexure is not accurately symmetrical, but that the dip on the N. side of the axis is somewhat steeper than on the S., and that the wave, therefore, is of the normal form. One consequence of this greater inclination in the strata of the N. flank is a less length of breast in the ore beds; but a

still more important result is in the more rapid increase in the thickness of the slates overlying the fossiliferous ore, reducing the amount of the soft or infiltrated portion. This section represents the prevailing form of the ridge, and the situation of the several outcrops of the different formations and their subdivisions for a length of 5 or 6 miles both E. and W. of Danville.

Along this distance the summit of the mountain is formed of the *Surgent* [*No. V Clinton*] *older slates*, which saddle it in a broad gentle arch. In some places the upper, in some the middle portions of this very thick formation occupy the anticlinal crest, and in certain localities the two outcrops of the *Iron-sandstone* approach, so as almost to coalesce and overlap it.

Throughout all this part of the range, each outcrop of the *Iron-sandstone* forms a shoulder on the slope of the mountain, between which and the foot of the central crest the declivity is comparatively gentle. The position of the Iron-sandstone is indicated to the eye, even at a distance, by a narrow belt of steep and stony ground, bordering the more gentle declivity of slate above it, and covered along its whole line by a skirt of woods, containing tall pines and other coniferous trees. It is on the higher portion of the mountain between these two outcrops of the *Iron-sandstone* that the *silicious iron-ore of the Surgent lower slate* [*No. V. Clinton*] appears upon the surface, usually in a double line of outcrop, the N. one about 800 or 900 feet S. of the N. line of the Iron-sandstone, and the S. one 800 or 900 feet N. of the Southern belt.

If we commence a detailed examination of the ridge in the vicinity of the Danville Narrows, 2 miles W. of the town, where the strata possess the particular type shown in the vertical column introduced in the preceding chapter, and trace the rocks E. and W. from this point, we shall find that for 3 or 4 miles along this central and most uplifted portion of the anticlinal belt, where the top of the Levant [*No. IV Medina*] white sandstone, though rarely seen, is elevated to the water-level, the whole crown of the ridge is overarched by the *Surgent older slate*, and the two

Plate XXXI.

FIG. 81.—Section of Montour Ridge at Danville.

FIG. 82.—Section of Montour Ridge at Hemlock Creek.

FIG. 83.—Section of Montour Ridge at Fishing Creek.

G^7.

outcrops of the Iron-sandstone are at their greatest distance from each other.

Here, at the place called the Narrows, an extensive denudation of the S. flank of the mountain exposes the bottom layers of the older slate. In a deep crescent-shaped excavation, more than 2 miles in extent, the upper strata of the S. slope have been removed; and thus all the rocks from the top of the *Levant* [*Medina*] *white sandstone* to the top of the red marl or shale are displayed in an oblique section. This excavation upon the side of the ridge has cut away, for the distance of two miles, the entire ore-bearing portion of the Surgent series above the river-level, and thus there is here an interruption in the outcrop of both the upper and lower calcareous ore shales containing the fossiliferous iron-ore, and also of the *Iron-sandstone*, the repository of the scarcely less valuable "hard ore."

In this natural section of the ore-shales we have an opportunity for studying minutely the position of the layers of fossiliferous iron-ore.

The *Surgent Ore-sandstone*, as represented in the column alluded to above, is distinctly seen in the form of a calcareous sandstone, only 7 or 8 feet thick, dividing the upper from the lower ore-shale.

In the *Upper Ore-shale* we have a formation measuring in all about 160 feet, composed of an alternation of bluish and greenish calcareous slates, with argillaceous blue limestone in the upper portion, and thinner layers of blue compact fossiliferous limestone in the middle and lower.

The lowest beds of this shale contain three or four bands of highly fossiliferous and ferruginous limestone; these are the equivalents of the fossiliferous iron-ore of some localities in the unaltered or undissolved state, but they do not represent the fossiliferous ore wrought along the flanks of Montour's Ridge, that bed appertaining, as our general column shows, to the *Surgent lower calcareous shale.* These layers are here too deficient in the oxide of iron to constitute a real ore. The dimensions and composition of the several component layers of the *Surgent upper shale* of this locality being fully described in the following sec-

tion (Fig. 84), any further details would seem to be superfluous.

The true fossiliferous iron of Montour Ridge, and indeed of very many other of the outcrops of the Surgent series in the Appalachian districts of the State, is merely a more than usually ferruginous bed of similar fossiliferous limestone in the *Surgent* [*No. V Clinton*] *older shale*, the place of which in the formation is seldom more than 30 or 40 feet below the bottom of the Ore-sandstone, the outcrop of which affords us thus an excellent clue to it. The older shale formation being at the Danville Narrows, and at Danville, about 60 feet in thickness, the place of the fossiliferous ore is about 25 feet above its inferior limit. At the Narrows, the ore-bed contains too little oxide of iron, and has not been sufficiently acted on by surface-waters to be worth the operation of smelting it. It would appear that Westward from this central locality of the Narrows of the Susquehanna, both the fossiliferous ore and the hard or block-ore of the Iron-sandstone are so much reduced in thickness, and in their proportion of oxide of iron, as to be, unless perhaps in a very few localities, quite valueless for economical purposes. I shall therefore confine my description of the structure and resources of the ridge to the more interesting part included between this point and its E. termination.

Iron Ores at Danville.

From the Narrows to the gap of Mahoning Creek at Danville, the length of outcrop of the two ores on the S. side of the mountain does not exceed about half a mile. That of the hard ore is considerably the longest; and, as the *Iron-sandstone* containing it outcrops much higher on the ridge than the other ore, the quantity of this exposed above the water-level exceeds that of the latter many times. In this part of the ridge, the average length of the slope or breast of the Iron-sandstone ore, *above the water-level alone*, is probably more than 200 yards; that of the fossiliferous ore is materially less, while, for reasons already shown, the

depth of breast of the soft and partially-decomposed ore may not average more than 30 or 40 yards.

The position of the hard ore, in the vicinity of the gorge of the Mahoning, is shown in our traverse section of the ridge at that place. By inspecting the vertical section which I have introduced of the Iron-sandstone formation, analysed in detail, the reader will perceive that while the red sandstone members include two or three excessively ponderous layers, rich enough in iron to be applicable as iron ores, the thickest of these—the only bed, indeed, which is of sufficient magnitude to be wrought at the present day—accompanies the lower bed of sandstone, and has dimensions varying from 14 to 18 inches.

But there is another formation here developed, in which beds of iron ore are discoverable. This is the *Surgent* (*No. V. Clinton*) *older or lower slate*, this stratum possessing in Montour Ridge a thickness of about 700 feet. Its ore has the form of a very ferruginous sandstone in one or two thin and continuous layers, occupying a horizon, near the middle of the formation, between 350 and 400 feet below its superior limit. Scarcely any difference is perceptible either in aspect or composition between the ore now referred to and that of the *Iron-sandstone.* It is a sandstone with a large proportion of peroxide of iron diffused among the particles, and, like the other bed, includes numerous small flat fragments, or pebbles of greenish slate, which by their disintegration leave the surfaces of the blocks, wherever the weather has had access, pitted with little elongated holes, forming one of the most distinctive features of these two ores.

This *ore-bed of the lower slate* outcrops near the summit of the ridge on the E. side of the Mahoning Gap at Danville, arching the anticlinal axis at an elevation of about 300 feet above the bed of this transverse valley. Traced E. and W. from the Notch, the overlying slate saddles it, and conceals it from view wherever the mountain is low and narrow; but wherever the anticlinal rises—or wherever, in other words, the wave in the strata increases in breadth and height—the ore no longer closes over the axis, but forms

two separate lines of outcrop, one on each gentle declivity between the summit and the shoulder, formed by the outcrop of the Iron-sandstone. In the vicinity of Danville, the thickness of this layer of ore is not such as to make it of much importance, so long as the thicker and therefore cheaper beds furnish an ample supply. Judging from the fragments at the point of outcrop, I infer its size to be between 6 and 8 inches. The facility and cost of mining it will of course depend upon several conditions connected with the dip and depth of covering, and will vary with each locality.

Our section of the strata at the Mahoning Gap represents the entire mass of the mountain as consisting there of the *two Surgent slates* and their included *Iron-sandstone*, while the calcareous or ore shales, with their fossiliferous ore, rest low at the N. and S. base. The upper beds of the *Levant [Medina] white sandstone* have not been lifted to the level of the bed of the Notch, though their depth beneath it cannot be considerable. This proves a sinking of the axis from opposite the Narrows to this point; but when the ridge is examined still further E., it becomes apparent that between the Mahoning and Hemlock, the anticlinal rises and swells again, causing the hard ore of the slate to diverge into two outcrops, and the belts of the Iron-sandstone to recede. About halfway between those two streams is probably the neighborhood in which the section of the mountain has its greatest expansion, and the two belts of the Iron-sandstone are furthest asunder.

Quantity of ore at Danville.

Let us now, before advancing any further E., attempt an estimate of the quantity of iron ore above the water-level within a given length—say one mile of outcrop—in the vicinity of Danville.

I shall reject from my present calculation both the ore of the older slate and the compact unchanged fossiliferous ore; the former as being too thin and deeply covered to be profitably mined, and the latter as too poor in iron, and too

calcareous, to be, under existing circumstances, adapted to the smelting furnace.

If we assume the soft fossiliferous ore of this neighborhood to have an average thickness of from 16 to 18 inches, which is probably not far from the truth, we may consider each square yard of its surface to represent about one ton weight of ore. Let us now adopt the estimate I have already given of the depth to which the ore stratum has been converted into this soft ore, and accept 30 yards as the limit. Each yard of length along the outcrop will then be equivalent to 30 tons of the ore, and one mile of outcrop should supply about 52,800 tons. This amount, it will be understood, is irrespective of elevation above the water-level.

Turning now to the hard or silicious ore of the *Iron-sandstone*, we shall find one mile of the outcrop-bed to offer a far more enormous quantity of available ore. It is obvious that the whole of the bed is convertible to use, since the composition of the ore is such as to make it fit for the furnace without its undergoing any solvent action, of which, indeed, it is scarcely susceptible. The only limit to the depth to which it may be profitably wrought, is the cost of mining it, and since this element is materially increased the moment we pass below the water-level of the locality, it will be expedient to restrict our present estimate to the quantity of the ore above this natural line.

It has been stated that in the vicinity of the Mahoning Gap, the average length of slope or breast belonging to the *Iron-sandstone* is about 200 yards ; on the S. side it is perhaps somewhat greater, while on the N. side it is probably as much less. This is equivalent to 200 tons of ore to each yard of the outcrop, the ore-bed being from 14 to 16 inches thick. One mile of length of outcrop will therefore yield 352,000 tons of the ore above the water-level.

All that portion which is in this position is therefore nearly seven times as great as the similar part of the soft fossiliferous ore.

The two ore-beds together represent more than 400,000 tons in a single mile of outcrop ; but as, from the anticlinal form of the mountain, there is a double line of outcrop for

each kind of ore, it is clear that one mile of length of the ridge must contain, upon the supposition of no deep ravines or notches intervening, the amazing quantity of 800,000 tons of ore.

It is to be remarked that in the foregoing statement I exclude the consideration of the ravines, which interrupt at frequent intervals the general line of the outcrop of the strata, and reduce materially the amount of ore above the water-level.

An abatement of one eighth from the quantity as above computed, on the supposition of a perfectly continuous outcrop, will probably more than compensate for the amount thus lost. With this reduction we shall still have, in one mile of the ridge, 700,000 tons of good ore.

The ore-estate attached to the Montour Ironworks of Danville, embraces, if I have been correctly informed, a total length of outcrop of the Iron-sandstone ore of 2200 yards, equivalent alone to 385,000 tons; the whole quantity of the soft fossiliferous ore I estimate at 45,000 tons; making the entire amount of ore available under existing circumstances 430,000 tons. Such is the apparently enormous extent of the mineral wealth of this favored locality.*

Between Mahoning and Hemlock Creeks.

It has been shown that, the anticlinal rising again E. of the Danville Gap, the lower strata become more developed upon the summit of the mountain, and the two parallel belts of ore on its flanks are wider apart at their outcrops. In consequence of this feature, the outcrops of the *Iron-sandstone* do not lie as high on the slopes of the ridge as at Danville, where a little greater depression of the axis would have caused this formation to saddle the summit. The extent of breast, therefore, of the *Iron-sandstone ore* above the lowest attainable level of the adjacent valley, is materially less than at the notch of the Mahoning. To command, moreover, this amount of breast without a resort to machinery, it will be necessary, in all this part of the outcrop, to pierce each base or slope of the mountain with tunnels; a necessity which must lessen essentially the value

* This estimate of the amount of fossiliferous ore at Danville was made in 1846.

of the ore, even if it should be found maintaining the richness and thickness which characterize it at Danville.

But personal observation, and the testimony of others interested in the truth, have convinced me that this important ore, which constitutes, as we have seen, the main portion of the mineral wealth of the Danville locality, becomes much reduced in thickness, and impoverished in its amount of oxide of iron, within the distance of even 1½ miles E. of the Mahoning Gap.

I have already stated that it declines in a similar manner when traced west.

Although the *Iron sandstone* forms a complete girdle round this middle division of the chain, embracing each slope, and closing round its E. end on the W. side of Hemlock creek, and although it is admirably well revealed to observation along both of its naked lines of outcrop, and at numerous little lateral valleys on the flanks of the mountain where its barrier is deeply breached, and the edges of the strata made visible, yet, in no single locality between the two gaps has the hard ore belonging to it been as yet discovered of a quality to make it fit for smelting. In some places a bed is met with holding the usual position of the ore in the stratum, and approximating imperfectly to the true ore in aspect and composition, but in no instance has it proved to be valuable ; it may, however, admit of being mined to a limited extent.

These facts of the impoverishment of this ore, one of the most important beds of the entire belt, are calculated to lessen greatly our estimate of the resources of this extensive portion of the ridge, and to awaken in cautious and far-seeing minds grave apprehensions of the ultimate capacity of the district to sustain with an adequate supply of ore that very large mass of capital, which, judging from the investments of the past few years, and the scale of present enterprises, appears likely to be embarked here in the smelting and manufacture of iron.

The *Iron sandstone* may be examined about 2½ miles E. of Danville on the S. side of the river, on a farm belonging to the Bloomsburg Iron Company, where it will be seen to

possess very nearly its Danville type—having, that is to say, 1. an *upper sandstone*; 2. a *middle stratum* many feet thick of yellow slate, and 3. beneath this a *lower sandstone.*

This last stratum exposes its outcrop by the side of a road leading into the ridge, and shows in the usual position the hard or silicious iron-ore, the fragments of which, however, are all small, and indicative of a very inferior ore.

Along the N. slope of the ridge the ore is recognizable under almost precisely the same associations, but it is generally too poor in oxide of iron ever to warrant the cost of developing its outcrop.

At the E. point of the main mountain, which terminates in a regular anticlinal slope at Hemlock creek, the layer of sandstone corresponding to the iron-ore has been mined in several spots by the Bloomsburg Iron Company, but hitherto it has disappointed anticipations in not containing a sufficiency of iron.

This being the true condition of the main bed of the silicious ore, let us next inquire into the degree of richness attained by the similar band which is interstratified with the Surgent lower slate.

I have already shown that from the influence of increased elevation in the whole anticlinal belt, and the denudation of the summit of the ridge, the same strata have not only a wider space in this position of the range than at the Mahoning gap, but the N. and S. outcrops are further asunder. It is owing to these causes that the formation here spoken of occupies so broad a belt along the top of the mountain, and that the layer of silicious iron-ore occurring near the middle of the mass, in place of forming, as at the Mahoning, an almost unbroken anticlinal arch, is traceable in two separate lines of outcrop, one on each comparatively gentle slope, at the base of the central crest, and above the line of the *Iron-sandstone.*

Such is the position of this iron-ore, the whole distance from the vicinity of Danville to a point about 2½ or 3 miles W. of the termination of the ridge at Hemlock creek. The *two belts of ore*, first gradually receding at their widest dis-

tance, range for 2 or 3 miles in nearly strict parallelism, then approach, and finally unite in a continuous arch upon the top of the ridge, and disappear beneath the mass of overlying slate. This junction of the two outcrops, and their final departure from the surface of the ore bed, occurs perhaps half a mile or more E. of Bittenbender's farm, upon which the N. outcrop of the ore has of late been experimentally mined by the Bloomsburg Iron Company.

The fact, already stated, that the usual surface-distance between the iron-ore and the Iron-sandstone along the S. slope is about 800 or 900 feet, and on the N. about 700 or 800 feet, though a sufficient clue to its general position must be accepted with some reservation, since these spaces will vary in obedience to changes in the inclination of the strata, and in the slope of the surface.

Bloomsburg I. Co. farm.—One of the localities at which we may examine the position, magnitude, and thickness of the ore, is on the S. side of the ridge 2½ miles E. of Danville, upon the farm once before alluded to as the property of the Bloomsburg Company. Here the outcrop of the ore is distinctly traceable in the slate, and its place is about 750 feet N. of the *Iron-sandstone.* A careful inspection of the fragments on the surface indicates its thickness to be about 7 or 8 inches, while their external appearance implies their good quality, or richness in the iron.

Samuel Wood's.—Another point at which the ore is well revealed is about 4 miles E. of Danville, on the N. slope of the mountain. At this spot the bed attains unusual thickness, and is mined in a somewhat systematic manner by the proprietor or lessee of the land, Mr. Samuel Wood. The ore, which appears to exist in more than one stratum, resembles closely the *Iron-sandstone* ore of Danville; though of somewhat variable dimensions the principal layer is from 18 to 30 inches in thickness, but every portion of this is not of the maximum degree of richness in the oxide of iron. This portion of the Northern outcrop, although at present but imperfectly developed, gives indications of its containing a very valuable amount of this important ore-bed.

Bittenbender's.—It is upon this belt, about 1½ miles fur-

ther eastward, that the ore is mined on the Bittenbender tract by the Bloomsburg Company. There the principal seam would appear to possess a less thickness than at the locality last mentioned, the bed, as displayed in one small drift, measuring only 8 inches. Fragments of the ore, indicative of a rather greater thickness, are, however, occasionally to be seen on the surface, and especially in the ravines below the line of the outcrop. Should this ore, which is amply rich enough for the furnace, and well adapted, in its chemical composition, to blend with an equal mixture of the soft and hard varieties of the fossiliferous ore in a triple mixture, prove on more extensive research to be sufficiently expanded to admit of being profitably mined, it will become a very valuable addition to the mineral wealth of Montour Ridge. The question of the actual amount of available ore along this line of outcrop is at present not susceptible of determination, and I shall abstain from an estimate which would necessarily be very conjectural.

Two anticlinals.—The reader must bear in mind, that although much uncertainty prevails concerning the real quantity of this hard ore of the lower slates, little or no doubt can exist as to the permanency of the valuable fossiliferous ore along both slopes of the ridge. I have already intimated that every longitudinal mile on each outcrop may be estimated to yield of the soft variety of the ore about 50,000 tons, or, making due allowance for ravines, more correctly, between 40,000 and 45,000 tons.

Moreover, it should not be overlooked that a portion of the compact or calcareous variety may in certain localities be advantageously mined where tranverse ravines and notches give ready access to the bed.

Montour Ridge consists, as I have shown, of two separate anticlinal ridges, the axes of which are not precisely in one continuous line. At the passing or overlapping of these two waves in the strata, there is of course an irregular synclinal trough, and although both the lower ore-beds,—that of the *Surgent lower slate* and that of the *Iron-sandstone*—are here depressed below the water-level at Hemlock creek by the subsidence of the two anticlinals, the fossiliferous

ore is not, but, on the contrary, is more extensively spread over the surface of the hill than at any point further W. The section (Fig. 82) of the end of the main or western ridge shows its structure immediately W. of Hemlock creek ; the observer looking W.

Flattened anticlinals.—The ridge is shown to retain nearly its full breadth, and to contain, besides its own proper anticlinal (seen on the left) the nearly exhausted wave of the E. Fishing creek ridge. This section renders apparent the reason of the much-increased amount of the fossiliferous ore here found above the water-level, for it exhibits the comparative flatness of both anticlinals, in virtue of which the strata, in attaining a given height above the valley, spread themselves in a longer and gentler slope than where the anticlinal is higher and its flanks steeper. But besides this increased extent in the ore-bed on both sides of the ridge, there is another and very valuable portion occupying the N. E. flank of the end of the mountain, in the form of an oblique basin or synclinal, where the ore, being sheltered in the trough, has escaped the destructive agency of the waters. It is obvious, from the comparatively flat position of a large portion of the ore-bed, and from its conforming extensively in its slopes with the inclination of the surface, that it is here spread out under a relatively shallow covering, and in a situation especially favorable to the conversion of a more than usual amount of it into the highly-valuable soft variety. To these structural conditions we must impute the wide distribution of the outcrop ore on both the E. and W. sides of Hemlock creek, and its singularly accessible situation for mining.

East of Hemlock Creek.

I now proceed to a brief description of the structure and resources of the eastern or Fishing creek division of Montour ridge.

This is a very regular and beautiful anticlinal, commencing, as we have seen, a little W. of Hemlock creek, on the N. flank of the main or Mahoning division of the ridge, and terminating about 3 miles E. of Bloomsburg. It is thus

about 5 miles in length; its extreme breadth is perhaps three fourths of a mile, while its height is between 400 and 500 feet. The only irregularity in its generally symmetrical oval form is along its N. side, where a large segment has been scooped out of its base, to form a part of the valley of Fishing creek. In their carving action the floods removed from this flank of the anticlinal a very considerable portion of the bed of fossiliferous iron-ore, which elsewhere mantles the whole N. slope of the ridge.

As represented in the foregoing section of the strata in the meridian of Fishing Creek, the flexure in which they span the ridge is almost perfectly symmetrical; perhaps the N. dips are somewhat the steepest. The whole amount of the vertical upheaval of the rocks upon the anticlinal axis, compared with their elevation in the main W. ridge, is less by several hundred feet; for while, in that part of the mountain, even the *Levant* [*No. IV Medina*] *white sandstone* is in one place lifted to the water-level, and the summit for many miles exposes the lower and middle members of the *Surgent lower slate*, the lowest strata upraised to the day in this other division of the chain are those of the upper half of the *Surgent lower slate.*

In the western hill the *Iron-sandstone* rests for a great space low on its two flanks, but in this E. anticlinal it almost over-arches the summit even at its highest part; in the western ridge, again, the ore of the lower slate mounts high on the slopes in two widely-separated outcrops, whereas here it is not elevated to within probably 100 feet of the water-level. Connected, therefore, with this seemingly trivial circumstance of a difference of vertical uplift of about 450 feet, are several very important peculiarities in the condition of the ore.

Lower ore.—In the first place the *ore-bed of the Surgent lower slate* is altogether absent at the surface, and can only be made accessible by means of a vertical shaft sunk over the crown of the anticlinal arch in the middle of the gorge of Fishing Creek. Such a shaft, starting near the water-level, would descend between 100 and 150 feet through the slate before it would reach the layer of ore. To construct

such a mine shaft would not involve a cost at all commensurate with the importance of a productive bed of iron ore of the quality which the band in question usually possesses, but in the existing uncertainty respecting the dimensions of the bed there is but little to induce an enterprise. I would, nevertheless, advise its construction at no distant day should the ore at the Bittenbender tract prove of insufficient thickness to warrant its being mined. We have already seen that this ore is very variable in its dimensions, and there is about an equal chance for and against its being here met with of such diameter as to make it a very important auxiliary to the native iron wealth of the Bloomsburg neighborhood.

The next bed of ore in the ascending series is that of the *Iron-sandstone* formation. This band of rocks spans the mountain at Fishing Creek to a great elevation, and both there and in other parts of the ridge is sufficiently well exposed to admit of its being critically studied. It it to be seen artificially and naturally developed, and very nearly of the type which it presents at Danville, at the N. base of the hill on the bank of the canal, which supplies an ample water-power to the furnace in the ravine of Fishing Creek. It agrees in all essential features, except in that which is of chief practical interest, the bed of silicious iron-ore. The very stratum, answering to the ore-bed, can be recognized as holding the exact position occupied by the layer at Danville, but it does not contain more than half its proper proportion of the oxide of iron requisite to constitute an iron ore. In other parts of the outcrop of the sandstone, a precisely similar deficiency is discernible in the layers holding the horizon of the ore, and we may therefore regard it as a definitely-settled fact, that throughout all this portion of the belt the *Iron-sandstone ore*, as such, has no existence.

It would thus appear that the only available ferruginous stratum is the fossiliferous iron-ore of the Surgent ore shales. Restricted as this part of the chain would at first sight seem to be as to its share of ore, it is nevertheless one of the most richly endowed of all the localities; and here we have a beautiful example, among innumerable others,

of the simplicity of nature's means for effecting the most striking compensations.

Though the fossiliferous ore alone occurs above the water-level, it is made, by the admirably-balanced influence of a particular degree of elevation of gentle curvature, and of denudation in the anticlinal wave, to hold just that position which is nearly the most favorable we can imagine for causing it to mantle the sides and ends of the ridge in an extensive sheet for producing the maximum amount of the soft or infiltrated ore, and for rendering its outcropping portion widely and cheaply accessible under a thin covering of loose superficial slate. In consequence of the oval form of the hill, connected with the gradual rising and expansion of the whole anticlinal, from Hemlock Creek to Fishing Creek, and its declension and contraction thence to its termination, the ore laps broadly, as I have already intimated, over both of its extremities, but does not rise high upon its N. and S. slopes. This produces, of course, a less amount of breast on the sides than at the ends.

But there is a further difference in the value of the ores found in these two positions, growing out of the very different extent to which the ore in its respective places has been deprived of its excess of calcareous matter, by exposure to surface percolation. Along both flanks of the ridge, the inclination of the strata exceeding very considerably the slopes of the surface, there is a rapid increase in the thickness and compactness of the slate formation reposing upon the ore-bed ; and consequently the depth to which the superficial infiltrations have had access is comparatively limited.

Thus it is that in these positions we usually find the change from the soft or dissolved part of the bed to the compact, to occur at a point from 30 to 40 yards below the actual outcrop.

On the other hand, at the two extremities of the ridge, the ore bed mantles over and around the long and gently declining terminations in a dip which is much more nearly coincident with that of the surface above it, and therefore a far wider outcrop of it is thinly overlaid by the slate, and

penetrated and altered by the atmospheric waters. This circumstance, and the much longer breast of ore spread out where the inclination is thus gentle, confers a greatly superior value upon these terminal portions of the ridge. In proof of this assertion it may be stated that while on the sides of the mountain the soft ore occupies but a narrow line, it covers almost the entire E. point of the ridge. Actual excavations for the furnaces, and numerous exploratory shafts, render it almost certain that the soft ore spreads across the end of the ridge in a continuous sheet, underlying perhaps some 150 acres or more at a depth below the soil in few places exceeding 20 feet.

The Bloomsburg Iron Company, owning two large furnaces in the gorge of Fishing Creek and using largely this soft variety of the fossiliferous ore, possess upon this extensive ore estate rather more than 2½ miles of the outcrop of the bed along the sides of the ridge, and in addition about 45 acres continuously underlaid by the soft ore in the E. end of the hill between two and three miles of Bloomsburg.

Quantity.—Each acre of the ore stratum contains, according to the most moderate calculation, not less that 3000 tons of ore, and the whole estate of the company has upon it between 200,000 and 250,000 tons of the soft outcrop ore; while I have estimated the quantity of the hard or calcareous fossiliferous ore in a readily accessible position at not less than 70,000 or 80,000 tons. When we advert to the admirable quality of the iron derived from a mixture of ores possessing a large proportion of the soft fossiliferous variety, and to the superior ease and economy with which it may be smelted, we cannot but esteem this whole E. anticlinal district of Montour Ridge as one of the most fortunately-conditioned ore localities in the United States.*

Total quantity of ore in Montour Ridge.

To render this description of the native riches of Montour ridge more satisfactory, I shall endeavor, in conclu-

* The above estimates were made in 1846 from all the data then accessible.

sion, to deduce from the foregoing data some general estimates of the aggregate mass of the iron ore in this favored tract. But it will be requisite, as a preliminary point, to determine the quantity that reposes upon the slopes of the E. or Fishing Creek division of the chain. Of course we can only form at present a rough approximation to the actual area occupied by the available part of the ore stratum; but even an imperfect calculation cannot fail to be useful to those interested in the resources of the region, and instructive to the general reader.

Of the more valuable variety, the soft or porous fossiliferous ore, we are warranted, I think, in assuming the quantity which overspreads the E. point of the ridge at 150 acres, and that resting upon the W. end, near Hemlock Creek, at about 50 acres.

To this amount we must add that belonging to the two long lateral outcrops. If strictly unbroken, each of these latter belts might be stated at perhaps 4 miles in length, making 8 miles for the whole; but we must deduct the vacant space on each flank of the ridge at the gorge of Fishing Creek; also that upon the N. slope E. of the Notch, where much ore has been swept away; and thirdly, the many smaller breaks produced by the hollows or ravines. Allowing one mile of soft ore as lost by all these interruptions, there will still remain 7 miles of outcrop. Let us adopt the above data, and we have from the first source 200 acres, yielding 3000 tons per acre, or 600,000 tons; and from the second, a belt 7 miles, or 12,320 yards in length, and 30 yards in breadth, giving 30 tons to each yard along the outcrop, or very nearly 370,000 tons in addition. The total amount of soft ore is therefore about 970,000, or approximately 1,000,000 tons.

It is much more difficult to speculate with any accuracy upon the aggregate quantity of the compact calcareous ore available for practical purposes; for we know as yet too little concerning the rate at which this deteriorates in descending, the limit of depth of such deterioration, and the steadily increasing cost of reaching it, whether by tunnels or by machinery, to affix accurate limits to the economical

working of the stratum. This ore is, moreover, intrinsically so much less valuable than either the soft fossiliferous variety or the silicious block-ores, that the limits here mentioned will be the sooner reached. With the restricted value which it must always possess so long as the soft variety lasts, I cannot conceive that it will be mined to an average depth of more than 30 or 40 yards, and it is very questionable if it will admit of being generally wrought to even that extent. If we suppose, as we may, that it possesses a total length in its circuit round the ridge of about 9 miles, we may infer the entire available quantity to be about 500,000 tons; and such will be nearly the amount wanted for mixture with the other ores—these having the quantities I have respectively assigned to them.

Let us in the next place examine the capacity as to ore of the W. or Mahoning Creek division of Montour's Ridge, the productive outcrops of which commence at Hemlock Creek and seem to terminate within one mile W. of Danville, except perhaps that of the N. flank which may extend somewhat further.

Upper ore.—Adverting first to the *fossiliferous ore* we shall probably be correct if, after rejecting the many interruptions which it encounters from ravines, including the wide gap of the Mahoning, we ascribe to this bed a length of outcrop equivalent to 8 miles on each side of the mountain, or a total length of 16 miles. If we now assume 30 yards as the average height of the belt of *soft ore*—and I am disposed to think this is somewhat too large an estimate for the portion of the ridge under consideration—the total quantity of this outcrop variety will be at most but 210,000 tons. Admitting that the *compact* calcareous kind can be wrought to additional depth of 30 yards, the available supply of this variety will be the same, or another 210,000 tons.

Middle ore.—Respecting the *hard block ore of the iron sandstone*, it has been already shown that this bed loses its valuable thickness and richness within one mile or 1½ miles E. of the Mahoning Gap, while we know that it is not traceable on the S. side of the ridge beyond the commencement

of the Narrows. If we assume the productive portion to constitute in all a length of outcrop equivalent to 4 miles, or about 7000 yards, we shall probably not underrate its actual extent, while we may safely estimate the average length of the slope above the general water-level as not exceeding 200 yards. It has been already shown, that, on the supposition of an average thickness of 14 or 16 inches, or about one ton of the ore to the square yard, the whole quantity in one such mile of outcrop is a little more than 350,000 tons. The total supply, therefore, from above the water-level, if our data are correct, will somewhat exceed four times this amount, or 1,400,000 tons.

Lower ore.—Our next and last estimate concerns the *hard silicious ore of the Surgent lower slate*, but in the present imperfectly-developed state of this bed, the data are insufficient for speculating upon the probable aggregate amount of its ore possessing the essential degrees of richness, thickness, and accessibleness. It is nevertheless obvious enough that the total length of the available belt is but a small fraction of its entire outcrop. I imagine it not to exceed 4 miles, and to fall probably much within this conjectural length. The position of much of this ore is such, in relation to the steeper slopes of the ridge, as to preclude its being very extensively wrought, since the tunnels, in the side of the mountain, requisite to command a large quantity above the water-level, would be of great length, and of a cost disproportioned to the value of the ore. Only the parts near the outcrop, and accessible from the ravines, can be profitably mined at the present prices of labor. If we estimate for this ore a depth of breast equivalent on an average of 50 yards, and even assume its thickness such that one square yard will represent one ton, we shall have for our conjectural belt of 4 miles a total of 352,000 tons of ore.

Total.—Let us now assemble together the above several numerical results, and ascertain the entire quantity of ore in an attainable position in Montour's Ridge, and available by the present generation :—

Of the soft fossiliferous ore—		
The Fishing Creek anticlinal contains	1,000,000	tons.
And the Mahoning Creek anticlinal	210,000	"
The total quantity of soft ore is therefore	1,210,000	"
Of the calcareous fossiliferous ore—		
The Fishing Creek anticlinal contains	500,000	"
And the Mahoning Creek anticlinal	210,000	"
The total of calcareous ore is therefore	710,000	"
Of the silicious ore of the iron sandstone—		
The Mahoning Creek anticlinal contains	1,400,000	"
Of the silicious ore of the Surgent older slate—		
The Mahoning Creek anticlinal contains	352,000	"
The total of silicious ore is therefore	1,752,000	"
The grand total of ore in Montour's Ridge is therefore	3,672,000	"

Mixture.—In reviewing these results, we are impressed with the interesting and very important fact, altogether unanticipated until this calculation had been completed, that the entire mass of the soft fossiliferous variety is about one third of the whole aggragate of iron in the belt; and experience has already fully demonstrated, that in smelting these several ores together, the lowest proportion in which this admirable variety can be employed to insure excellence in the iron, and economy in the working of the furnace, is about this ratio of one third. Should the other kinds be ultimately ascertained to exist in quantities materially greater than those I have assigned them from calculation, the portion in excess above my estimate will, after the exhaustion of the soft fossiliferous sort, possess but comparatively little value, through the lack of a fitting ore wherewith to mix it.

Duration.—An interesting inquiry here suggests itself as to the probable duration of this apparently inexhaustible amount of ore, under the active consumption which is now going on. According to the most accurate information I have been able to procure, there have been, for the past several years, about twenty furnaces, some of the largest dimensions, some of medium capacity, deriving their supplies

of ore from this single belt. To each of these furnaces we may attribute, without exaggeration, an average annual productiveness of 3000 tons. If we now reason upon the basis that these iron-works must hereafter, if they have not already, put themselves on mixtures of the several ores, in which the average proportion of the soft fossiliferous sort shall not surpass one third, we must assume that it will demand three tons of the mixed ores to yield one ton of metal. The average consumption for a furnace must therefore be about 9000 tons per annum, and the total yearly supply for the twenty furnaces not less than 180,000 tons. But at this rate of consumption the seemingly vast aggregate of available ore in Montour's Ridge is destined to be entirely exhausted in the short space of twenty years. It should be kept in view that this somewhat startling inference assumes a still graver aspect when we reflect on the probable steady future augmentation, for a time at least, in the number of the furnaces which will seek for their supplies of ore from this important belt. Stimulated as the prosperous iron manufacture of Pennsylvania is at present by the seemingly well-grounded anticipations of sustained prices and a future vigorous growth, the calm counsels of prudence and dispassionate science have little chance of being heard and adopted, until loss and suffering to a greater or less extent, through a too lavish application of capital, shall recall their suggestions.

In the hope, however, that opinions drawn from an honest and laborious investigation of the facts, and expressed through no motive but one of duty, cannot pass altogether unheeded, I here venture, in closing this subject, earnestly to press upon the ironmasters consuming, or about to consume, the iron ores of Montour's Ridge, to economize their soft fossiliferous ore, the quantity of which is far from boundless, while the possession of it in a certain proportion is vital to their prosperity. Let them, in every instance where it is practicable, reduce the proportion of the ore in their mixtures to one half or even one third, and let them not forget that this ore is the present key to all the remaining riches of their region; that when it fails them, much of

the other ore must be left untouched where it now reposes; and with its final exhaustion must come an enormous, almost a total, loss of all their fixed investments.

[*Note by Prof. H. D. Rogers in 1858.*] The above estimates and views were committed to paper in 1847, and though some fresh developments have extended a little the area of the soft ore, time has fully confirmed their general soundness.

APPENDIX B.

Notes on the Mehoopeny Coal-field.

Mr. Frank A. Hill of the Anthracite Survey was instructed to make a reconnoisance of the eastern end of the Bernice basin, while Mr. E. B. Harden was surveying the Sullivan county part of the area, with a view to the extension of the survey eastward into Wyoming county. Mr. Hill commenced his reconnoisance at Mehoopeny, August 27, 1883.

The contact of *Catskill* (IX) with *Chemung* (VIII) is at the mouth of the Mehoopeny creek; R. R. elevation, 634.5 A. T.

Forkston is five miles up the creek at the forks of the north and south branches, and about 150 feet higher; about 750′ A. T.

The mountain which occupies the area between the branches, south-west of Forkston, rises steeply about 1200′, to about 1950′ A. T.

Massive conglomerate rocks, horizontal, cap the mountain.

No ravines descend the north face of the mountain into the valley of the North branch; but all the streams of the mountain plateau flow south and east, cutting down into the South branch.

This of itself shows that the gentle dip of the rocks of the mountain is towards the south; the North branch cutting eastward against the basset edge of the stratification.

That there is a gently south-west fall of the mountain rocks is shown by the fact that the coal-crops on the Forkston mountain are higher than those of Bernice in Sullivan county.

Up the South branch, about a mile above Forkston, is Squire Spaulding's house.

The easternmost coal opening (No. 1) is about half a mile from Spaulding's house, on the crest of the mountain west of the South branch, and north of a small stream called Stony brook.

Another coal opening (No 2) (F. Chrisman) is on the mountain crest between Stony brook and Spring brook. Here a gangway has been driven 390 feet, and a number of breasts have been turned. The operators report 1000 tons mined.

The bed is quite regular; thus:

At mouth, ...	Coal, 2' 10"	Bone, 7"
260' in gangway, ...	" 3' 2"	" 6"
At heading, ...	" 2' 6"	" 4"

At 260' in, fire-clay, 5" thick, covers the bed.

At mouth, fire-clay, 4' 4" thick, makes the floor.

A massive conglomerate forms the roof everywhere.

This No. 2 Chrisman opening is about 2100' A. T., or more than 200' higher than the lowest coal bed at Bernice; a good argument for the Chrisman coal bed being, as Prof. White makes it, above the *Mauch Chunk shale* (No. XI) if not in the body of the Conglomerate, (No. XII.)

The rise of the measures eastward also justifies Prof. White in assigning the whole of Wyoming county east of the Susquehanna river to the *Catskill formation*, (No. IX.)

Daddow's opening (No. 3) mentioned by Mr. Platt in Report of Progress, G', page 205, is at the west end of the same coal area (between Stony and Spring brooks) where the descent is westward to the head springs of the Loyal-sock and near the county line. In fact this is the highest land in this part of the region.

Daddow's opening is more than a mile west of Chrisman's opening, and the outcrop is continuous between them, there being another opening (No. 4) on the coal halfway between them.

Going up the Mehoopeny south branch from Forkston, five large brooks descend from the flat crest of the very high mountain divide between it and Bowman's creek. These are in order (going south-west) Scouten brook, Cassan brook, Henry Lott brook, Somers brook, and South brook.

Scouten brook enters the south branch 2 miles south of Forkston. It descends from the mountain south-east of Forkston.

Coal smut is reported on the Polly Elliott and Wm. Hall tracts at the headwaters of Scouten and Cassan brooks, but nothing definite is known about it.

At the head of H. Lott's brook a very high summit commences and extends south-westward, past the head of Somer's brook, to the head of South brook. Coal is said to appear at the heads of these three brooks.

The divide continues on south-west across the Wyoming county south line into Luzerne county, and a sixth large brook descends into the Mehoopeny south branch a mile or more higher up than South brook. At the head of this also coal appearances are reported.

All these mountain top areas are faced with a massive conglomerate which seems to be the same, and therefor ought to cover the same coal bed; whether in workable condition or not can only be told by experiment.

There is no perceptible dip, although very careful spirit-leveling would of course show that the horizontality is not perfect.

The same state of things continues westward across the Sullivan county line and around Lake Ganoga in that county. The rocks there, described in Report G[3] as *Pocono sandstone* (*No. X*,) resemble in a marked manner the rocks capping the mountain west of Forkston, which seems to be *Pottsville Conglomerate* (*No. XII.*)

There are two conglomerates—one above the coal bed, coarse and heavy, the other under the coal bed, less coarse and interleaved with sandstone beds.

The upper or roof conglomerate has a thickness of 40 feet where best exposed.

The lower conglomerate and sandstone mass seems to be from 250 to 300 feet thick.

In the midst of this lower mass is seen a little coal bed a few inches thick.

Along the bottom line of this lower mass issue chalybeate springs, depositing bog iron ore. This was the mark by

which, in the first geological survey of the State, the top of the *Mauch Chunk formation* (*No. XI*) and the bottom of the *Pottsville Conglomerate formation* (*No. XII*) was always recognized, especially in south-western Pennsylvania along Chestnut ridge and Laurel Hill. See the reports of 1837 to 1841.

This is the place of the iron ore bed of Somerset county, the Queen's run ore of Clinton county, the Ralston ore of Lycoming county, &c.

A solid bed of ore is exposed on Pigeon run near Ganoga lake, in Sullivan county, in this situation, and again on Ore run, where Col. Rickitts got the following section:

Soft yellow and whitish shales,	10' 0"
Ore, bluish and greenish-gray,	4"
Slate, greenish,	8"
Ore, same as above,	1' 3'
Slate, greenish,	1' 0"
Ore, same as above,	1' 7"
Shale, reddish,	5' 0"
Ore, same as above,	1' 0"
Shale, reddish,	1' 0"

Mr. Hill made a (barometric) section on the mountain slope descending Stony and Red brooks to the Mahoopeny south branch, as follows:

Conglomerate roof of Chrisman's coal, visible	25'
Coal bed,	2' 10"
Interval concealed,	100'
Interval to where the red wash in the stream stops,	50'
Sandstone slaty and sandstone yellow,	90'
Conglomerate, massive,	40'
Red shale, with some yellow shale,	120'
Sandstone, gray and yellow,	30'
Interval concealed,	10'
Red shale,	3'
Interval concealed,	30'
Sandstone, greenish-gray,	35'
Interval concealed,	85'
Occasional slight exposures of sandstone,	420'
Shale, white,	3'
Red shale,	35'
Sandstone, greenish-gray,	45'
Shale, white,	0' 8"
Red shale,	— —

We have here then the following series:

CONGLOMERATE, coarse, heavy,	say 40'
Coal bed,	3
Shale, red, &c.,	150'
Sandstone, . . . 90', } CONGLOMERATE, . 40', }	130'
Red shale,	120'
Sandstones and soft intervals,	615'
Red shale,	35'
Sandstone,	45'
Red shale,	—

In other words the top of the real red shale mass seems to come 280' beneath the coal, and just under a lower conglomerate. The question is: Is this No. XI, or is it No. IX?

If it be No. IX, then the *Pocono* formation is represented by only 130' of sandstone and conglomerate; and the *Mauch Chunk* by 150' of soft interval just under the coal; which will then be the Campbell's ledge plant bed, as Mr. White supposes.

But if it be No. XI, then the coal bed is near the top of the Conglomerate, which will then be about 300 feet thick, as it is all through Western Pennsylvania.

My surveys on the Towanda mountain, in Bradford county, (not more than twenty miles distant to the northwest,) made with instruments of precision, gave me the following section:

Conglomerate and sandstone,	60'
Coal bed,	1'
Sandstone,	80'
Iron ore bed, solid,	3'
Sandstone,	70'
Red shale, of XI, in force,	—

Here the iron ore is not at the bottom, but in the midst of the Pottsville conglomerate, which measures in all (above and below the coal bed) 214 feet.

The progress of the Anthracite Survey has revealed such remarkable variations in the productive coal measures and in the underlying formations, that we must patiently wait for further developments. It is useless to generalize on insufficient data. It is unnecessary to conceal the fact that, as the First Survey left the *Sub-carboniferous* geology of the State in a very confused condition, the Second Survey

has not by any means entirely cleared up that confusion, although great progress has been made towards a final settlement.

What we now need is good topographical work in the North mountain region, and a large number of carefully measured detailed sections for comparison.

Different members of the survey have employed the terms, *Pottsville conglomerate*, *Mauch Chunk red shale*, *Pocono gray sandstone*, and *Catskill red sandstone*, differently; and there is good reason for believing that a complete re-adjustment of names must be made before the whole truth can be told.

J. P. L.

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Communications relating to the work of the survey should be addressed to J. Peter Lesley, State Geologist, No. 1008 Clinton street, Philadelphia, and those intended for the Board of Commissioners, to William A. Ingham, Secretary, No. 320 Walnut street, Philadelphia.

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J. SIMPSON AFRICA,
Secretary of Internal Affairs,
Harrisburg, Pa.

October 4, 1883.